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PHLEBOTOMUS AND OROYA FEVER AND VERRUGA PERUANA

HISTORIANS of the early seventeenth century, writing of the conquest of the Incas, refer to the Peruvian Indians as suffering from numerous warts ("verrugas"), varying in size from small red prominences to masses as large as eggs, and covering the face and limbs. Many of Pizarro's soldiers developed the warty condition and died of the fever sometimes attending it. In their ignorance they attributed death not to the peculiar disease but to fish or water supposed to have been poisoned. In earlier times the disease seems to have occurred in regions now in Ecuador, but at present it is confined to the provinces of Lima, Ancachs and Libertad in Peru, lying in south latitude 9° to 13°.

The distribution of the disease is curious. The districts at sea-level and 25 to 35 miles inland are free from it, but as the mountainous parts are approached the disease makes its appearance, and foci or endemic centers are encountered at altitudes of 9,000 feet and over. In certain narrow clefts, called "quebradas," the disease has prevailed in a severe form from early periods, and strangely enough a given village may be severely ridden and a neighboring one a few miles distant may escape entirely.

In 1870, during the construction of the trans-Andean railway, an acute, febrile and fatal disease carried off many thousand laborers in the region between Lima and Oroya. One feature of this destructive malady was an anemia so profound as to have blanched the color of the natives or, in local language, to have changed "blacks" into "whites." Another curious circumstance noted at this time was that the workmen escaped the disease so long as they avoided certain localities at night. A single night passed in these danger zones might be followed by fever and death. Finally, the laborers were removed from them before sunset, and after this was done the disease abated.

This severe disease of the Andes was called Oroya fever, and while it might run its fatal course without other symptoms than fever and anemia, yet at times it was attended by the warty skin affection previously mentioned; or, when recovery occurred, the "verrugas" might appear. Conversely, sometimes the warty disease arose attended only with mild fever and anemia. Because of their frequent association in the same individual and their common geographical distribution, the

two conditions, Oroya fever and verruga, came to be regarded in the popular mind as one disease appearing in a malignant and in a benign form.

The identity of the two forms was, however, a controverted point, and to settle it a medical student, David Carrion, in 1885, inoculated himself on both arms with tissue juice taken from "verrugas." He developed Oroya fever and died. Since this self-sacrificing experiment the malady has often been called Carrion's disease. In 1905 a Peruvian physician, Barton, discovered in the red blood corpuscles of Oroya fever patients certain rod-shaped bodies resembling bacilli, and later similar rods were detected in small numbers in the blood of verruga patients. These bodies were named *Bartonella bacilliformis* by the Commission of the Harvard School of Tropical Medicine in 1913 and regarded by them not as bacterial but as protozoal organisms. Many attempts were made to develop the rods in artificial cultures but without success. Such bacteria as were cultivated proved to be either secondarily invading organisms (paratyphoid bacilli) or extraneous contaminants. That the verrucous disease can be transmitted by inoculation from man to monkey has been known since 1909, but the Harvard Commission was unable to detect any of the rod-shaped organisms either in the human warts or in those induced in animals.

In 1925 Dr. T. S. Battistini, a Peruvian fellow of the Rockefeller Foundation, brought to one of us (Noguchi) a specimen of blood taken from a case of Oroya fever. The red corpuscles of the blood contained the rods, and cultivation experiments were undertaken which resulted successfully (Noguchi). The microorganisms obtained in the cultures reproduced on inoculation into monkeys and apes experimental diseases agreeing with both Oroya fever and verruga. Subsequently the microorganism was isolated from the blood of two other cases of Oroya fever and seven of verruga peruana, and from the skin nodule in a case of verruga (Noguchi). The bacterial incitant of the disease was now isolated, and the important fact determined that, as grown outside the body, it was capable of infecting monkeys, in which could be induced the two characteristic manifestations of Carrion's disease.

The one essential point which remained to be established in order to account for the origin of the disease was the mode of infection. Indications pointing to direct transfer from person to person were wanting, while evidence implicating insects in the transmission existed. The strict limitation of the endemic zone of the disease and the nocturnal dangers pointed to an insect source of inoculation. This aspect of the subject had been investigated in 1913 with remarkable energy and penetration by Charles H. T. Townsend, an American entomologist. He gave consideration to all kinds of blood-sucking insects to be found in the verruga zone, and, after excluding one and another variety of insects, finally, in a brilliant manner, concentrated attention on certain blood-sucking gnats of the class Phlebotomus. By excluding all insects whose range extends outside the verruga zone, he reduced the possible carriers to buffalognats, horseflies and phlebotomi, and by excluding the insects which bite by day as well as by night, he reduced the possible verruga vectors to phlebotomi alone. So certain did he feel of his discovery that he called the gnat "*Phlebotomus verrucarum*." Townsend went one step further in attempting experimental induction of verruga in dogs and man by means of phlebotomi. It is doubtful whether he actually succeeded in this undertaking.

With the artificial cultivation of the rods, the mode of transmission was opened to rigid experimentation. One of us (Noguchi) discovered that *Bartonella bacilliformis* can be taken up by the wood tick from the blood of an infected monkey and be transferred to a healthy monkey through bites. Probably this is a purely mechanical process without significance so far as the natural insect vector of Carrion's disease is concerned. The next step was actually to test insects from the verruga zone in Peru. The International Health Division of the Rockefeller Foundation was invited by the Department of Health of Peru to send an entomologist to Peru, and one of us (Shannon) spent five months there studying insect life in the verruga zone and collecting and sending to the Rockefeller Institute insects for purposes of inoculation, according to a plan arranged by Dr. Noguchi before he sailed for Africa to study yellow fever. The phlebotomi collected and identified consisted of *Phlebotomus verrucarum* Townsend and two new species named respectively *P. noguchii* and *P. peruensis*, which are readily differentiated from each other and from *P. verrucarum* by the sex characters of the males. Only the females are blood-suckers, however, and those of *verrucarum* and *noguchii* are indistinguishable, hence some doubt must remain whether the females of both species carry *Bartonella bacilliformis*. We are confident that the females of *P. noguchii* are carriers, and we think that *P. peruensis* is probably not a carrier.

Other blood-sucking insects which were tested by inoculation are ticks (Argasidae), mites (Trombidium), midges, sheep lice, bird lice, bedbugs, mosquitoes (*Anopheles pseudopunctipennis* and *Culex fatigans*), buffalognats (*Simuliidae*), flies (*Stomoxys calcitrans*), "sheep ticks" (*Melophagus ovinus*), Streblidae of blood-sucking bats, and fleas of guinea-pig and dog. None of these was found to harbor *Bartonella bacilliformis*.

The plan followed was to inject saline suspensions of the crushed insects into the skin of *rhesus* monkeys. No verrucous nodules developed. At regular intervals thereafter cultures were made from the blood of the inoculated monkeys with a view to determining whether the Bartonella had entered the blood and multiplied in it. Four different lots of phlebotomi, as tested in this way, were proved to carry *Bartonella bacilliformis*. In the first instance the culture was obtained with blood withdrawn from the inoculated monkey on the 19th day, in the second on the 20th day, in the third on the 10th day, and in the fourth on the 42nd day. The inoculation of monkeys with the cultures thus obtained produced experimental verrucous nodules, with recovery of the Bartonella from the blood and the nodular tissue. The chain of evidence uniting Phlebotomus with Oroya fever and verruga peruana may be said to have been completed by these tests.

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THE RELATION OF RESEARCH TO WEALTH PRODUCTION[1]

WEALTH is produced by the performance of work upon the materials of nature as we find them on and in the earth's crust. In the term work is included not only the actual physical work done by men and machines, but also the work performed by capital, and this includes the use of money and of the facilities which money purchases. Wealth then represents an accumulation of something above actual requirements for maintenance and is usually represented by some form of money or negotiable exchange. The extent to which research contributes to wealth might, therefore, be discussed from the point of view of the increased possibility of producing from natural resources desirable commodities in excess of immediate requirements, and we at once think of the extent to which savings have been made in the physical labor required in carrying out the industrial program of the world.

While for the purposes of discussion wealth may be taken in this case as something measured by dollars, nevertheless the less tangible but equally important contributions of science to things cultural and even spiritual must not be overlooked, and because of these factors a complete evaluation of the contributions of science is well nigh impossible. To attempt to measure in terms of wealth as it is usually understood the value of a local anesthetic, the beauty of a synthetic color, the pleasure of a synthetic scent or the value of a medicinal produced from a coal-tar base becomes an absurdity. While statisticians have succeeded in arriving at figures which express the probable value of a life in terms of earning power or cost of development and education, we are still unable really to value a life in terms of money, and the close relationship between modern science and the life of our age makes it equally impossible really to measure the contributions of research to wealth, when considered in the broadest sense.

But to revert to the subject of eliminating drudgery, of doing by chemistry, physics and mathematics as applied to industry much of the work which formerly required endless hours of time. It is fairly well agreed that an enormous amount of human energy was expended in the construction of the pyramids and in beautifying ancient Greece and Rome, but it is doubtful whether any modern agency could afford to lavish the labor of hundreds of thousands of human beings on such an enterprise. It is only when the world is at war that such great blocks of labor are employed for a common end. In those ancient days slavery was held to be justified because slave labor enabled the patrician and the philosopher to have the necessary leisure to make their type of contribution to the welfare of the state. It is doubtless true that through the contributions of science the average individual to-day has an amount of leisure far beyond that experienced at any other period of the world's history, and an increase in leisure is almost directly in proportion to the contributions which science makes in the perfection of industrial processes and means for doing the world's work. Indeed, many hold that the vital problem of our times is the manner in which this additional leisure is to be invested, and we progress or retrogress as we employ this leisure constructively or destructively.

Our telephone companies carry some twenty billion communications a year, these messages covering more than fifty billion miles and involving work which if performed by messengers working nine hours a day, making a high average of ten miles per hour, would require seven million individuals at a cost of eleven billion dollars. The contributions of a long line of research workers enter and we see this labor performed by a few hundred thousand em-

[1] Read before the general session of the association devoted to the work of the Committee of One Hundred on Scientific Research at the Nashville meeting.

ployees of the telephone companies connected with something more than twenty-five thousand central offices and employing perhaps twenty million telephone instruments, the whole representing an investment of around two billion dollars and handling the business at one twentieth of the cost of the messenger service, even if we were able to employ so large a proportion of our working population for it.

Remembering to what extent paper enters into our civilization, it is well to note that if to-day all our paper had to be formed as hand-made sheets by the primitive methods still employed for some grades of special papers, a disproportionate number of our working population would be required to supply the more than one hundred and fifty pounds of paper per capita which America now consumes annually—a weight in excess of that of its total population.

Compare the rate at which holes may be drilled by the primitive flint-tipped drill operated by bow and string with the capacity of the modern tool-steel drill. Or consider the value of the contribution of modern lighting, or again the modern factory employing electricity, where one thousand workmen virtually direct the labors of an additional twenty thousand represented in the motors at their disposal. A slave power year to-day costs a little more than five dollars.

Explosives, a contribution of science, make possible works of construction so that a hundred men in ten months can accomplish what in the days of Claudius would have taken the labor of thirty thousand men over a period of eleven years.

Such examples could be multiplied at length, but the point of each illustration is the same. One way of measuring the relation of research to wealth is to measure the production which a given number of men can accomplish in a given time, thereby adding to the time available for other constructive efforts or for leisure.

That research creates new industries is equally apparent to any scientist who gives it thought. It creates them because it finds new materials and then devises ways to use them. These two steps are nearly sure to be separated by long periods of time, and some fundamental discoveries have had to wait a century to realize commercial development. The gradual employment of the gases in industry is an outstanding example of this, and but recently our attention has been called to how much argon does by doing nothing, reference being made to its assistance through the incandescent light, enabling us to obtain greater service for the dollar spent for illumination. The remarkable development of the sulfur beds which underlie portions of Texas and Louisiana is directly due to the chemical and physical constants of the element sulfur, determined as a piece of academic investigation. The fact that a stormy day in New York City is worth a million dollars to the manufacturers and retailers of raincoats and rubbers is due to Goodyear's contributions and to the numberless improvements in the technology of rubber manufacture, all of which are based upon fundamentals established through gradual and painstaking work in the research laboratory. Industries like the photographic industry have been established essentially upon a single scientific fact, and no industry would exist but for a firm foundation which science has built for it, though until recently unrecognized.

Whatever progress has been made in combating corrosion, it is not improper to credit research with the principal victories. But losses due to rust and decay will continue in staggering amount until the research laboratory determines why and how these materials of construction are destroyed or impaired. When we know the causes, it is safe to predict that corrective measures can be prescribed.

To a group of scientists it is idle to stress the part research has played in waste prevention and utilization. Every one can cite for himself and from his own field of experience abundant examples to establish the claim of research as a most potent factor in enabling man to use natural resources with the highest efficiency. There are classical examples in cotton products, in the meat-packing industry, in the cereal grains, in metallurgy and indeed in whatever way we wish to turn. That research has at times rescued established industries is also a claim that can be made with ample foundation, and it is noteworthy that the Welsbach mantle was of the utmost assistance to the manufactured gas industry through the period between the advent of the incandescent lamp and the more universal recognition of gas for power and fuel purposes.

That profitable industry is often revolutionized by the results of research is shown through the application of the principles of catalysis and surface phenomena in many lines of endeavor. To these may be credited such vast enterprises as the fixation of atmospheric nitrogen, the contact process for the manufacture of sulfuric acid, the hydrogenation of oils, the production of synthetic methanol, and much of the work that has been done abroad on the manufacture of petroleum-like bodies from gases derived from coal. It is useless to express the wealth represented by these enterprises, for the figures are great beyond our understanding.

What research means when applied to stretching the natural resources to keep up with world demands

is another service of inestimable value. What has been accomplished in increasing the productivity of agriculture, in preserving its products from one harvest to the next, and in the development of new species and varieties to suit particular locations and limitations of climate are but other reminders of the debt which civilization owes to those who work quietly and persistently in research laboratories and who for the most part are rewarded principally by the knowledge of a task well performed, by the plaudits of their fellow scientists and by a salary which too often is too meager to relieve them of financial worry.

There is always danger that a scientific man will claim too much for his efforts and while it is true that darkness has been banished, isolation broken, drudgery reduced, climate altered, the prospect of famines decreased, life extended and protected, and real poverty reduced almost to the vanishing point, it must be admitted that quite frequently the contribution of the original discoverer is but a few per cent. of the total effort involved in making the results available to people at large. There can be no development without the discovery, and yet the discovery must be followed by a great investment of time and money, in pilot plants, in semi-commercial-scale production, and ultimately in the provision of those facilities representing capital and labor which are the essential steps between the brilliant discovery of the scientist and the article which can be sold at a price to make it available to a great consuming public. The contributions of research to wealth, therefore, are so fundamental that it is difficult to claim too much, and yet with proper modesty the scientist may recognize how essential is the support of capital, labor, the public in general, if his research is to become useful. It is always well to recall the words of Millikan, that research to be justified must ultimately be useful.

All of what I have said and much more that could be said may be summed up very clearly, I think, by reference to the inscription on the beautiful dome of the building of the National Academy of Sciences and National Research Council in Washington. The logical development of the thoughts expressed in this quotation cannot fail to impress upon the minds of all, whether scientists or laymen, the key position which research occupies in the creation of wealth by whatever standard you care to measure it—"To science, pilot of industry, conqueror of disease, multiplier of the harvest, explorer of the universe, revealer of Nature's law, eternal guide to truth."

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FAMILY BUDGETS OF UNIVERSITY FACULTY MEMBERS[1]

FOR a long time the low salary of the professor has been matter of discussion. Those who deplore the relative smallness are sometimes in the profession, but more often are men and women in other professions. Of late, however, expressions of unrest have become very audible in academic circles, perhaps because of the rise in the cost of living and of the changes in the standards of living in all classes which now include even the conservative college professor. The younger generation of this profession is, I think, unanimous in believing that the salary now offered in the academic world, especially to its higher ranks, is not one that can fairly be expected to meet the needs of the professional family.

This assumption that, given the accepted professional standard of living, salaries usually paid university teachers will not meet family living expenses and that to maintain the standard, supplementary earnings or vested income, one or both, become necessary, seemed to invite verification by the test of expenditures. In 1923, a keen interest in the real facts behind such statements led the writer to ask a number of faculty members at the University of California to give help in testing the truth of the assertion that salaries did not pay for needs.

Requests were sent to the two hundred forty-seven persons who represented the married members of the faculty. One hundred twenty-one of these refused to participate. Of the one hundred twenty-six who accepted the invitation, thirty could not, for one reason or another, be included in the study.

By the beginning of February, 1923, ninety-six complete family schedules were available, a number which represented 50 per cent. of the married members of the University of California faculty.

Characteristically this group of ninety-six families was made up of men and women in the prime of life and of their descendants under sixteen. Sixty-two per cent. of the men of the families were somewhere between thirty-five and fifty years of age; their wives, slightly younger. The families were typically American, born in the north and west of the United States. On the whole, the households were of the modern "small-family" type. The size of family showed an average of 3.5 persons.

When the facts of income and expenditure obtained by the interviewers were tabulated and interpreted, the assumption that salaries do not meet the scale of

[1] Read before the general session of the association devoted to the work of the Committee of One Hundred on Scientific Research at the Nashville meeting.

wants seemed entirely verified. These ninety-six families showed an average family expenditure of $5,000 per annum and this total was required in despite of budgets which evidence the utmost diligence and care in the use of the family income.

Salaries did not supply the $5,000 necessary for this scale of wants. Indeed, in three fourths of the cases salaries did not pay for the goods and services regarded as necessary. Seventy-five per cent. of these ninety-six faculty families supplemented salaries by other earnings. In 47 per cent. of the cases, salary was more than three fourths of the income; 40 per cent. reported salary as less than two thirds of their total income. For all ranks of the faculty members in the group studied, the mean salary was 65 per cent. of the total income. Vested income played relatively little part in the income of most of the group. Of the ninety-six families studied, only five cases reported property income that exceeded the income from work. An exceptional case showed salary as only 13 per cent. of the total income, returns from property and additional earnings making up the rest. But in the major part of this group of ninety-six families, salary was added to by forms of work other than regular university work which yielded an average return in sums that range from $1,000 to $2,000. The salary range of this group was $6,000, that is, from $1,400 to $8,000. The income range was $13,200, from $1,800 to $16,000. Massing is, of course, in the lower income groups. Only one family was trying to live on less than $2,000, only two commanded more than $12,000. The average mean income from all sources proved to be $5,300; the median, $4,800. This is to say that 60 per cent. of these ninety-six families had total incomes of less than $5,000.

Can a professional standard be maintained on less than this $5,000? Does not this sum represent the minimum cost of health and decency? In certain circles this question challenges ironical reference to the bald fact that statisticians tell us that 86 per cent. of the nation does live on less than $2,000; that only 600,000 of this prosperous nation are supposed to be enjoying $5,000 a year or over. It may be that the professor has no justification for his desire to be included in this two per cent. of the nation's income-earning population. The fact is he does so desire, because, as consumer, he has a scale of wants that with the current price level requires $5,000 or more to satisfy it. Also, and this is the gist of the findings here presented, the budgets secured seem on inspection to show a scale of wants and a habit of spending endorsed by the most conservative teachers of thrift.

In general, when statistically examined, the expenditures all showed spending ways it would be difficult to call careless or extravagant, all obviously followed the plan advocated vigorously by all schemes for "wise spending." In these expense histories, the emphasis fell most heavily on what used to be called "the higher life," those items of an important class of expenditures which as yet have no well-established name. For lack of a better term, these items, such as investment, insurance, savings, automobiles, recreation, health, dependents, gifts, education, professional expense, association, church, charity, tobacco, were grouped in this study under the heading "miscellaneous." The thirteen items in this subdivision and the items of house operation are those which give special character to the spending reported by these university families. The mean cost of living for the whole group of ninety-six families whose average size was 3.5 persons proved to be $5,511.77. For the professors the average expenditure proved to be $7,014.80. The instructors reported an average expenditure of $4,016. On an average, seventeen per cent. of the income was allotted to food; nine per cent. to clothing; shelter absorbed an average of seventeen per cent.; house operation, a caption that covers twelve rather important items, took thirteen per cent.; miscellaneous, with its thirteen sub-items, averaged forty-three per cent.

These percentages contrast notably with the percentage distributions of expenditure being sent out for popular consumption. Banks and other publishers of budget forms tell us that, with an income of $4,800, the expenditure for food should be eighteen per cent. to twenty-five per cent.; for clothing, eleven per cent. to eighteen per cent.; for shelter, fifteen per cent. to twenty-five per cent.; for house operation, from thirteen per cent. to twenty per cent.; for miscellaneous, including investments and savings, is ordinarily assigned from twenty-six per cent. to forty per cent. In the study whose findings I am presenting, the professors of this faculty, as a rule, spent for miscellaneous, forty-eight per cent. of their income. For miscellaneous the associate professor spends forty-six per cent. and the assistant professor, thirty-eight and two tenths per cent. The instructors and associates gave fifty and four tenths per cent. and forty-two per cent. respectively to these two items. Engel's law is once more verified. As the total amounts expended annually increase, the percentage these families assign to food and clothing regularly decreases in favor of expenditures for some one of the thirteen items of miscellaneous.

These families spend an average amount of $900 for food, a sum that passes everywhere just now as

the cost of minimum food requirements for those living at a subsistence plus level. The same extreme simplicity plainly dictates clothing expenditures. Two thirds of the husbands and one half of the wives spent annually between $100 and $200 each for their personal wardrobes. Thirteen women and eight men reported spending less than $100 each. The maximum spent by either sex, in families with the highest income, was about $500. One of the surprising facts which developed was this: although the simplicity in clothing of the average professor is traditional, in 40 per cent. of the families the housewives spent less than their husbands. The reason for this low expenditure of the adult members of the families does not seem to lie in the cost of the clothing of their children. Here also the least amount was spent. Plain clothing was evidently standard.

With regard to shelter, as might have been expected by those knowing the ways of academic people, a different standard appeared. The mode of desire is expressed in "a dwelling of seven or eight rooms," which requires a relatively high proportion of expenditure for shelter. Seventeen per cent. as an allotment to housing costs is not high in relation to a total income of $5,000, but the amount is disproportionate in comparison with the percentage these families allotted to food and clothing.

House operation, as analyzed in the schedule of inquiry that was used, contained items that ordinarily scatter under the headings such as rent and sundries. In this study, the term "house operation" covered a group of expenditures, such as light, fuel, heat, water, ice, telephone, telegraph, garbage removal, personal and house-cleaning supplies, house laundry, all types of domestic service, furniture and furnishings. These items took as an average 13 per cent. of the income with a range from 4 per cent. to 30 per cent. Fuel and heat represented an average cost of $100. Fuel, heat and light averaged $140. One among the outstanding facts which the study developed was the way these ninety-six families consistently aimed to dispense with domestic service or at least to use a minimum of it. Ten per cent. of these wives of professional men spent nothing for help in their housework. Fifteen per cent. paid $25 or less during the year under discussion. No family with a total expenditure below $6,000 had a full-time resident help. Even in families with incomes about $6,000, two thirds paid only $200 or more annually for help. The desire to save the costs of domestic service appeared in every family. Indeed twenty-one of the wives, most of them college-bred women, did all their own laundry work, from desire to save or to spend on other things.

As has been said, the allotment to miscellaneous took from one third to one half of the income. One third of the families paid for the support of one dependent or more outside the home, a cost that runs from three per cent. to ten per cent. of the total expenditures.

Fifty-five of the ninety-six families reported owning automobiles. For these fifty-five families, this item took 6 per cent. of the total expenditure, 17 per cent. of the miscellaneous expenditures. As might be expected, the tendency to own automobiles appears more regularly when incomes are over $4,000. Between $2,000 and $4,000 a trifle over one third of the families owned cars. At the level of $4,000 to $6,000, 50 per cent. had their own cars. Between $6,000 and $10,000, three fourths had automobiles. With incomes over $10,000 nearly 90 per cent. had automobiles. Apparently $6,000 to $7,000 was the income level where professional families felt free to buy automobiles. In nearly two thirds of the cases it was reported that they were spending less than $500 annually on their cars, but one third spent more than $1,000. In the group of fifty-five who own cars, 11 per cent. reported no expenditures for domestic service, apparently preferring to spend for the combined service and recreation which an automobile represents.

For forms of recreation other than automobiles, the average expenditure proved to be about $200. The amount spent for commercial amusements was notably small. Social entertainment seemed to be the preferred form and the tendency is toward a fixed allotment for this item.

A careful examination of the costs of ill health seemed worth while. Consequently, totals were obtained for the amounts paid for doctors, dentists, drugs, hospitals and opticians. Of the ninety-six families only two reported no expenditure for sickness. On the other hand, a few families quoted amounts very high indeed. Five families, two of whom had incomes under $5,000, reported health costs between $1,000 and $2,000. One instructor's family of four persons living on $3,400 was constrained during the year 1921–1922 to spend 25 per cent. of the total income on this item. However, for two thirds of the ninety-six families, expenditures for health absorbed less than 6 per cent. For 16 per cent. the item took $500 or more. The average physician's bill was $75. Forty families paid specialists amounts that averaged $35. Ninety reported dentist bills whose average was $50. The costs of the services of optometrists averaged $30, paid for by fifty-five families. The thirty-six who reported hospital bills, quoted sums that averaged $62. The twenty-three families who set down a nursing charge showed an average of $45. It was interesting to note that the higher expenditures for dentistry appear in the higher ex-

penditure levels only. It seems fair to argue that the lower cost of dentistry in the lower income groups is in part due either to inability to pay or at least to a relative unreadiness to allot money to dental prophylaxis.

As might be expected, expenditure to provide against the future takes first place in the general spending plan of these families. As a whole, investments absorb 26 per cent. of miscellaneous and 13 per cent. of the total expenditure, more than clothing and very little less than food or shelter. Only four families made no report of expenditure for this item. Of these, two families were buying homes, an item classified as an investment. Life insurance was the most recurrent type of "investment." Sixty families reported savings other than insurance. These appear as bank savings in thirty-six cases and as stocks and bonds and other forms of securities in thirty-eight cases.

The reports concerning gifts suggest that a fixed standard controlled expenditure for this item. The expenditure for all levels of income averages about $100 annually, 2 per cent. of the total expenditure, 5 per cent. of miscellaneous. As the proportion allotted to miscellaneous increases the relative cost of gifts decreases.

The amount which the academic man himself spent on professional expenses appears amazingly small, although it has a wide range and varies according to the amount paid out for technical books and magazines, for secretarial service, for professional organizations and travel for professional purpose. The amounts reported range from one per cent. to 38 per cent. of the total income. Of ninety-six men, twenty-two spent less than one half of one per cent. The average expenditure is $60, or 1.3 per cent.

The schedule used aimed to reduce the item of incidentals to the lowest terms. The number of subitems included expenditures difficult to classify otherwise, such as carfare other than that spent for going to and from work, lawyers' fees, barber service, moving expense, funeral expense and the like. Nearly 80 per cent. of the families investigated spent less than $100 on incidentals. Study of this item included the discovery that the average cost of all tonsorial service for man, wife and children was $13, a fact that raised the question whether economy, a preference or preoccupation dictated this infrequent patronage of the barber.

The costs of association dues, that is, affiliations with social clubs, vary slightly from one per cent. Expenditure for church and charity proved to be comparatively small. It is interesting to report, though difficult to explain, the fact that the fifty-two members of the group who recorded church contributions were those with small expenditures and that it was generally true that the percentage supporting churches decreases as total expenditure rises. For the fifty-two families out of ninety-six who supported churches the contribution varied from one tenth of one per cent. of the total expenditure to 7.5 per cent. In only two cases was more than 5 per cent. of income dedicated to this purpose. One family gave 7 per cent. of total expenditure, or $350. For charitable purposes, there was a wide range from one tenth of one per cent. to four per cent.

Only sixty-three of the ninety-six families reported any expenditure for tobacco. For these sixty-three families apparently tobacco is regarded as a fixed charge rather than a luxury permitted only when income rises. The highest and exceptional amount spent constituted one per cent. of the annual income. The median amount spent was less than one twentieth of one per cent., or about $25 per annum.

To summarize, these ninety-six families, at every income level, spent for the items of investments, automobiles, health, recreation and dependents outside the home an average of one fourth to one third of the total expenditure. Every family met charges for recreation, health and investment. Fifty-seven per cent. had automobiles, one-third had dependents outside the home to care for. An average of 2 per cent. of the total expenditure went for gifts. Education took 1.5 per cent. Professional expense was always about the same charge upon income, taking a trifle over one per cent. Church, charity and tobacco absorbed less than one per cent. Thus the outstanding facts concerning the expenditures of faculty families seem to be these: As the total expenditure increases, more is spent for investment, especially if the income becomes $5,000 and up. The proportion assigned to recreation and health decreases with increase of income. Expense for gifts, professional expense, church and charity remain a constant proportion of the total for all classes of income. The cost of tobacco is irregular and seems to bear no direct relation to purchasing power.

The table on page 501 shows these facts in detail.

All these facts could be more readily evaluated, if there were any accepted standards by which to test these expenditures. The field of expenditure is as yet the playground of the moralist.

The aim of this study was to let exact methods tell a story. Arguments on a speculative basis are less convincing. But even facts call for some criteria by which to evaluate them. Unfortunately such criteria in relation to standards and costs of living are not always formulated scientifically or clearly. There is little knowledge about human needs, real or custom made. Most claims for the amounts required

MEAN AND MEDIAN AMOUNTS AND PERCENTAGES OF TOTAL EXPENDITURES ALLOTTED TO EACH ITEM OF THE BUDGET

	Number of families reporting expenditure	Amount of expenditure		Percentage of total expenditure	
		Mean	Median	Mean	Median
Total expenditure	96	$5,511.77	$4,893.22	100.0	100.0
Food	96	$893.73	$807.50	17.3	16.8
Clothing	96	487.78	440.33	9.4	8.8
Shelter	96	871.11	684.50	17.1	15.8
House operation	96	746.49	568.21	13.1	12.2
Total miscellaneous	96	2,512.44	2,047.19	43.1	41.2
Investments	90†	774.34	357.50	12.7	7.9
Automobile	55	673.35	364.00	10.3	6.2
Recreation	96	286.50	197.85	5.1	4.1
Health	95	316.33	203.16	5.7	3.9
Dependents	34	250.39	200.00	5.1	3.1
Gifts	94*	123.41	100.00	2.3	2.0
Education	96	164.06	69.30	2.6	1.5
Professional expenses	93*	169.27	60.00	2.9	1.3
Incidentals	95	93.23	55.00	1.7	1.2
Associations	94	75.74	49.70	1.3	1.1
Church	52	64.01	30.00	1.3	0.6
Charity	90§	41.47	27.00	0.7	0.6
Tobacco	61*	34.21	25.00	0.6	0.4

* In 1 additional case, expenditure was reported but the exact amount was not available.
† In 2 additional cases, expenditure was reported but the exact amount was not available.
§ In 3 additional cases, expenditure was reported but the exact amount was not available.

to meet standards of living rest upon unsettled questions about the nature, the quantities and the costs of the several levels of living. Wise men, democrats and perhaps demagogues, unite in questioning the relation between income, a long scale of wants, and healthful and comfortable modes of existence. Much can be said for the Greek idea of the opportunities that lie in avoiding comfort. The country editor who, when he read my statement about $5,000 being not enough for comfort at a professional standard, waxed eloquently indignant about the lack of economic sense of those who spend $1,000 to $2,000 a year on automobiles, tobacco and recreation, has everything in favor of his position, except matter of fact. Inexorable custom jostles him and all professional men daily. Standard of living is not a question of prerogative but of practical utility. Like the rest of those who earn, the professor is in a specific occupational group. The idealists notwithstanding, occupational relationships react to settle effectively customary notions about modes of living. Given, the test of custom, the standard and cost of living displayed by the facts shown in this paper are minimum for professional men; these show the habitual mode of living that those who have spent long years in training for the profession consider "necessary and proper."

If the salaries of the full professor at least can not yield the average of $5,000 necessary to satisfy "custom" needs such as these budgets display, it is to be feared that men of initiative will leave the classrooms of universities to classroom plodders.

JESSICA B. PEIXOTTO

THE UNIVERSITY OF CALIFORNIA

THE INDUSTRIAL SIGNIFICANCE OF SOME RECENT DEVELOPMENTS IN ORGANIC CHEMISTRY[1]

WHEN I compare the little I have to say with the length of my title I feel like a microbe with a Latin name.

My appearance on the program anyhow is due far more to my desire to have an opportunity to congratulate the Division of Industrial and Engineering Chemistry on its fine record of accomplishment during

[1] A paper read on September 11, 1928, at the meeting of the American Chemical Society at Swampscott, Massachusetts.

the twenty years of its existence. It was authorized, as some of you remember, in 1908 and began to function in that year, its activities thus antedating those of any other division of the society. I recall with much pleasure that I had the privilege of serving as your first chairman.

The following year the *Journal of Industrial and Engineering Chemistry* began publication. We may fairly claim it as our official organ, though we will permit other divisions to share the pride we take in its splendid service to applied chemistry and its great value as a source of revenue to the society. It is the only self-sustaining publication of the society and, as an addition to our assets, is equivalent to an endowment of at least a million dollars, since it yields a net income of about $70,000 a year.

We may also fairly claim a continuity of identity in those other divisions, which, by a process of budding or cell division, have extended and segregated our activities into gas and fuel, petroleum, sugar, rubber, cellulose, leather, medical products, sanitation and other fields.

But I must not forget that I am expected to say something about the industrial significance of some recent developments in organic chemistry.

We are all familiar with the great and diversified industries which have the aromatic compounds as their basis. We are now entering an era of industrial development in which the aliphatic compounds, and especially those derivable from petroleum, seem likely to prove of equal or greater significance. In my own laboratory we have demonstrated that the vapor-phase cracking of petroleum for gasoline results in the incidental production of a large volume of gas composed chiefly of unsaturated compounds, of which the olefins constitute the greater part. From them it is now easy to proceed to the preparation of secondary and tertiary alcohols, chlorhydrins, glycols and solvent esters. It seems altogether probable that within a few years the production of these compounds, together with ethyl and isopropyl alcohols and their derivatives, will become an important adjunct of the petroleum industry and yield petroleum products of a new order of value. Through processes developed in our laboratory there was secured in small-scale commercial operation, at Tiverton, Rhode Island, per barrel of gas oil consumed, 19 gallons of motor fuel of 437° F. end-point, .85 gallons of tertiary butyl alcohol, 1.65 gallons of secondary alcohols, propylene convertible into 2.5 gallons of isopropyl alcohol, together with 800 cubic feet of residual gas, 25 per cent. of which was ethylene.

It is time for the sugar industry to look about for new uses for molasses. Some such new uses are in sight, as in the fermentation processes for the production of glycerine, but those which offer the greater promise of tonnage consumption are concerned with the preparation of protein foods from yeast. Whereas it requires about a hundred pounds of foodstuffs to produce five pounds of beef and three acres of land to support a cow, thousands of pounds of solid yeast protein can be developed and separated in a few hours in a very limited space from molasses and many other wastes containing fermentable sugars.

Ethylene, which constitutes the major proportion of the gas developed by vapor-phase cracking, has marked advantages over ether for anesthesia and is also the basis of a new technique for the ripening of fruits. One cubic foot of ethylene a day introduced into a room of 5,000 cubic feet capacity will bring oranges to that golden color which nature requires weeks to develop. Lemons picked grass green and carefully cured with ethylene compare favorably in every way with lemons ripened on the tree and will ship better.

Tomatoes, celery, bananas and other fruits lend themselves to similar treatment to advantage, and we may even look forward to a time when melons will look even more like melons and taste less like squash.

At the meeting of the Society of Chemical Industry, just closed in New York, Dr. F. E. Denny gave some remarkable demonstrations of the influence of various organic compounds, and conspicuously that of ethylene chlorhydrin, ethylene dichloride and sodium thiocyanate, in shortening the normal rest period of plant buds. Potatoes so treated sprout nearly two months earlier than they otherwise would, and in many localities it is thus made possible to grow two crops a year instead of one. Similar treatment of the buds of flowering plants enables the horticulturist to secure blooms at seasons otherwise impossible and when his product can command abnormal prices.

A field of much industrial significance has been opened up by processes developed along independent lines by Penniman, James and the du Pont laboratories for the oxidation of petroleum hydrocarbons. These have resulted in the production, by relatively simple means, of whole series of alcohols, aldehydes, ketones and fatty acids. The immediate problem appears to be that of separating the products from the complex mixtures in which they are first obtained.

From pentane, by the Sharples process, which involves its chlorination, the various amyl alcohols are now produced in quantity and their acetates are available as solvents for nitrocellulose.

The extraordinary development within the last five years of nitrocellulose lacquers and finishes has pro-

vided a powerful stimulus to research in the fields of paints, varnishes and solvents. The production in this country of these lacquers and finishes has grown from about 2,000,000 gallons in 1923 to approximately 25,000,000 gallons in 1927.

The low-temperature carbonization of coal is the subject of intensive study in many countries, including our own, and sufficient progress has already been made to demonstrate its commercial feasibility. It seems destined ultimately to have a profound effect upon the gas industry and to hasten the day when our cities will be measurably free from the smoke which now defiles them. The light tars which are produced in quantity in low-temperature carbonization are markedly different in character from ordinary coal tar and are a promising field for scientific investigation as a preliminary to the development of a new coal-tar industry.

Coal seems destined in fact to play a part of greatly increased importance as the raw-material basis of new chemical industries. In support of this opinion I need only mention the success of General Patart in France in effecting syntheses of alcohols and aldehydes from water-gas; that of Fischer in Germany for the production, also from water-gas, of the whole series of paraffin hydrocarbons from methane to solid paraffins; and finally, the remarkable results secured by Bergius in the liquefaction of coal. While it does not seem probable that we shall for many years to come turn to water-gas as the source of liquid and solid hydrocarbons or substitute for petroleum products the oils derived from coal, it may easily happen that we shall convert water-gas to methane and thereby permit the gas industry to distribute a non-asphyxiating gas of such enhanced heating power as to double the energy-carrying capacity of the distribution systems. It also seems probable that through the application of the Bergius method of hydrogenation the tars and bottoms of the petroleum industry may be converted into lighter and more valuable products.

The rubber industry, which has heretofore based its operations on the use of coagulated crude rubber, is now entering upon a new period of development, which, though originally based upon rubber latex, is being extended to include artificial dispersions made from crude rubber, vulcanized rubber or reclaimed rubber by milling and kneading the rubber with water and an inert material such as clay, and with the addition of small amounts of some protective colloid. Many important applications involving the use of rubber dispersions are already well under way.

Much interest has recently been aroused in the problems concerned with the possible utilization of the immense amounts of agricultural wastes annually produced in this country. As to their quantity you may take your choice between estimates ranging from 500,000,000 to a billion tons a year. It is enough in either case to concern those interested in the conservation of our resources. It goes without saying that there are in these wastes a quality and an amount of vegetable fiber adequate to supply a large proportion of our requirements for paper stock, and it is obvious to you that from this purified cellulose the whole range of products based on cellulose compounds can be made. Whether they can be made at a profit is quite another question. It can only be answered after yields of fiber, costs of collection and many other economic factors have been determined. There is now so much activity in this field that it seems probable that reliable answers to these questions may soon be forthcoming.

ARTHUR D. LITTLE

CAMBRIDGE, MASSACHUSETTS

SCIENTIFIC EVENTS

THE LIFE AND SERVICES OF JOHN WARREN. 1874–1928

THE following minute was placed on the records of the faculty of medicine of Harvard University at the meeting of November 1, 1928:

Five generations, in direct succession from father to son, of men eminent in the medical profession, men intimately connected with the Harvard Medical School or the Massachusetts General Hospital—this is a record for which Boston may well feel a proper pride and deep gratitude. In the death of the last of this direct medical line the Harvard Medical School suffers a profound loss.

John Warren, associate professor of anatomy, died suddenly on July 17, last. His connection with the anatomical department had lasted twenty-eight years, for he was appointed assistant in anatomy in 1900, the year after his graduation. From the very beginning of his career his chief interest lay in teaching. His position brought him under the influence of his kinsman, Dr. Thomas Dwight, then Parkman professor of anatomy, a forceful and very lovable example of the older type of professor, by whom the didactic lecture was considered paramount for instruction. It may be that intimate association with Dr. Dwight or perhaps a native gift handed down from his great-great-grandfather, the first professor of anatomy at Harvard, accounts for John Warren's proficiency in the art of the careful preparation and clear and forceful delivery of anatomical lectures, of which he soon became a master. With this he also attained a depth of knowledge of human anatomy and a skill in displaying it by dissection which were acknowledged by all his colleagues in later years and appreciated by a long succession of medical students.

Living as he did in a surgical atmosphere, trained to believe that a sound and detailed knowledge of human

anatomy was the essential foundation of every practitioner, he constantly endeavored to improve the older methods of teaching while preserving the basic principles. After Dr. Dwight's death, he raised a memorial fund—the Dwight Fund—to be used for the acquisition of specimens or other material which might be of value to the student. Later he planned and created the Dwight Room, a teaching anatomical museum situated among the dissecting rooms and therefore immediately available to the students. Always a skilled dissector, he himself supplied most of the specimens for this museum, and spent much thought and care on their arrangement and availability for study. Within the last few years he decided to use this abundant material in the preparation of an atlas of anatomy. Beautiful drawings of his dissections have been made, on which he expended years of patient care. That he was not destined to see the completion of this work must be deeply regretted. In all these activities his one idea was that of helpfulness to the student; his viewpoint was that of the teacher.

John Warren's administrative ability was early recognized. In 1903 he became the youngest member of the faculty and since then has been called upon to serve on numerous faculty committees. In 1911 President Lowell appointed him university marshall, in charge of the commencement day exercises. Many graduates will remember the dignity which his presence lent to these yearly gatherings, even though they may not realize the thought and infinite care necessary in their preparation.

During the war this same faculty for administration secured for him posts of considerable importance in the army. His interest in military matters remained after his discharge from military duty, and it is in large part due to his influence that the medical unit of the Reserve Officers' Training Corps now exists at Harvard.

He was always interested in historical matters, as was natural in one of his lineage, and within the last few years became a collector of old books on anatomy, a pursuit in which he was particularly happy. These volumes he added to those already in his possession, handed down from father to son in his family. This truly notable collection he has now bequeathed to this school as a memorial to five generations of Warrens.

Unfailing courtesy, straightforward simplicity and a deep loyalty to this school and to the university mark his career as a teacher. His sweetness of character was well known to his friends. He carried on worthily the tradition of service handed down by his ancestors.

J. L. Bremer,
Harvey Cushing,
Walter B. Cannon,
Committee

THE PROPOSED NATIONAL INSTITUTE OF HEALTH

The creation of a National Institute of Health is proposed in a bill introduced by Senator Ransdell, of Louisiana, and now on the Senate calendar of business to be considered during the forthcoming short session. The bill has been approved by the Senate Committee on Commerce. The report submitted by this committee recommending the enactment of the bill says:

The object of this bill is to promote the health of human beings, to improve their earning capacity, to reduce their living expenses, to increase their happiness and prolong their lives.

It seeks to prevent disease by ascertaining its cause and applying preventive measures in advance of its outbreak. It has unselfish interests to serve, and its beneficent results will enter every home in the nation.

It appreciates that disease is universal and ignores state and national lines, hence it seeks to establish in this Capital City a great national institute of health in the belief that it will become a clearing house of health for all the world.

It has received the indorsements of distinguished men of science, and of the national organizations of related scientific research.

The bill contains three distinct features.

First, the creation of a National Institute of Health in the Public Service under the administration and control of the surgeon-general, for the special purpose of pure scientific research to ascertain the cause, prevention and cure of disease affecting human beings. It does not create any new bureaus or new commissions, but utilizes existing government machinery and provides for much enlargement of the hygienic laboratory, which is merged in and made an essential part of the National Institute. It authorizes appropriation of such sums as may be adequate to carry out the provisions of the measure.

Second. It authorizes the Treasury Department to accept gifts unconditionally for study, investigation, and research in problems relating to the health of man and matters pertaining thereto, with the proviso that if gifts in the sum of a half million dollars or more are made, the name of the donor shall be attached thereto.

Third. It proposes the establishment and maintenance in the institute of a system of fellowships in scientific research in order to secure the proper scientific personnel and to encourage and aid men and women of marked proficiency to combat the diseases that menace human health.

In conclusion the committee reports:

We are disposed to feel hopeless over the time required for the solution of these intricate and difficult problems of the health of the individual. Yet the necessities of war gave us clear illustration that when researchers in the several sciences are brought together and given adequate facilities and full time for research, results can be accomplished at a speed hitherto undreamed of.

Surely we would be unfaithful to our responsibilities if we do not profit by this striking example and apply similar defenses for the battle of man with disease. Our failure to act will mean a deliberate sentence of sorrow and suffering in the homes of our constituents.

Favorable action will mean an effective start along the road which ultimately will lead to successful solution.

As an economic question, there can be no difference of opinion on the wisdom of such an investment of public funds; as a social question, none can equal it in importance.

MEETING OF THE TRUSTEES OF THE AMERICAN MUSEUM OF NATURAL HISTORY

The Trustees of the American Museum of Natural History held a regular meeting in New York on November 12, immediately following a luncheon given by President Henry Fairfield Osborn. The November meeting is the most important one of the year, as at this time a general report of the activities of the museum for the current year is furnished and the future progress and scope of its work, as well as the financial problems confronting it, are given.

Following a policy initiated by President Osborn a few years ago, creating committees of trustees, who should concern themselves with the different branches of science in the museum and become responsible for their development, reports of the chairmen of fifteen such committees were given. The African and Asiatic Halls and their collections, which are directed by Trustees Daniel E. Pomeroy and Junius S. Morgan, Jr., respectively, are having the preparation of their groups hastened to completion. All of the specimens for these groups have been the gifts of supporters of the museum. In the case of the African Hall, the donors are George Eastman, Daniel E. Pomeroy, the late Col. D. G. Wentz, Arthur S. Vernay and Mr. and Mrs. G. Lister Carlisle, while the groups in the South Asiatic Hall were collected by Arthur S. Vernay and Col. J. C. Faunthorpe and are the gift of Mr. Vernay.

Favorable reports were given by Mr. George F. Baker, Jr., on the development of the Morgan Hall of Minerals; on geology and geography, by Dr. A. Hamilton Rice; on the department of paleontology, by Childs Frick; of the increased interest in anthropology and archeology, by Clarence L. Hay; of the collection of nearly extinct mammals, by Madison Grant; of the progress made in the Hall of Ocean Life, by George T. Bowdoin; of insect life, by George D. Pratt; on the Hall of Fishes, by Cleveland E. Dodge; on amphibians and reptiles, by Douglas Burden; the additions to the library, by Ogden Mills; the report on education, by Felix M. Warburg. President Osborn reported that forty expeditions had been in operation during the year, thirty-two of which were privately supported. The field activities were reported and especial comment made upon the work of such as the Central Asiatic Expedition, the Roraima Expedition to British Guiana, the Vernay Expedition to Indo-China, the Whitney South Sea Expedition, the Carlisle-Clark Expedition to Africa, seven expeditions for fossils to New Mexico, Arizona, Montana, Texas and Florida, the Stoll-McCracken Arctic Expedition, the Tyler-Duida Expedition to Venezuela and others.

DEDICATION OF THE ENGINEERING LABORATORY OF PRINCETON UNIVERSITY

The new engineering building at Princeton University was dedicated on November 15 with ceremonies attended by delegates from more than a hundred universities and engineering schools. At the formal ceremonies Charles Z. Klauder, the architect, turned over the keys of the building to President Hibben, who accepted them in the name of the trustees. Dean Greene made an address. A luncheon was later given at Princeton Inn, at which Carlton S. Proctor, of New York, president of the Engineering Association, Dean Augustus Trowbridge, of the Princeton Graduate College, and Dean Dexter Kimball, of the Cornell Engineering School, spoke.

The cornerstone of the building was laid May 12, 1927, Dr. Michael I. Pupin, of Columbia University, being the principal speaker. The cost of construction was $500,000. At the same time building operations were begun on the new chemical laboratory, which is still under construction. Although not fully completed, the engineering building was opened to classes at the beginning of this semester.

Civil engineering at Princeton was established in 1875, and graduate electrical engineering in 1889. In 1921 these were merged and enlarged into the School of Engineering, adding mechanical, chemical and mining engineering.

The engineering building has been designed in the collegiate Gothic style of the other Princeton structures. The entrance leads into a foyer, opening into the library, the conference room and the two stair halls. The library, which is finished in Gothic detail, will serve as a study hall, with reference books and current periodicals. The conference room, constructed and furnished by the Princeton Engineering Association to emphasize the factor of beauty in the equation of efficiency, is planned for meetings and informal consultations.

The building contains three wings, in which are found classrooms, drawing rooms for each class and laboratories. The north laboratory contains a high-pressure boiler and superheater, steam engines and turbine with condensers and outside cooling tower, internal combustion engines, dynamometers for testing these engines and automobiles, refrigerating apparatus, air compressors, fan blowers and transmission apparatus of the belt and gear form. The three south laboratories are devoted to electrical engineering and hydraulics. Direct and alternating current

machines, reaction and impulse turbines, pumps and hydraulic apparatus are to be placed in these rooms. The long testing flume will be used for current meters and models. The second floor contains a laboratory classroom for electrical instrument work, a dark room for illumination and oscillograph work, small rooms for mechanical work and a large room for research.

THE AMERICAN PHYSICAL SOCIETY AND THE UNIVERSITY OF MINNESOTA

The autumn meeting of the American Physical Society will be held at the University of Minnesota on November 30 and December 1. The new laboratory of physics of the university will be dedicated on the evening of the thirtieth. The program is as follows:

November 30

10:00–12:00 M.
Reading of Papers, Physics Auditorium.

12:00–1:30 P. M.
Luncheon, Ballroom, Minnesota Union.

1:30–5:00 P. M.
Dedicatory Symposium, Physics Auditorium.
Professor Hermann Weyl (University of Zürich): Address: "Laws of Conservation and Rules of Intensity in Quantum Mechanics."
Professor K. T. Compton (Princeton University): "Scattering of Electrons."
Professor E. U. Condon (Princeton University): "Quantum Theory of Aperiodic Effects."
Dr. F. L. Mohler (Bureau of Standards): "Photoionization and Recombination."
Dr. Irving Langmuir (General Electric Co.): "Motions of Positive Ions in Ionized Gases."

6:00–8:00 P. M.
Complimentary Dinner, Ballroom, Minnesota Union, Dean G. S. Ford, presiding.
Welcome to Guests—President L. D. Coffman.
Response—Dr. Karl T. Compton.
Addresses—Dr. W. F. G. Swann and Professor S. C. Lind.

8:15 P. M.
Dedicatory Exercises, Physics Auditorium, President L. D. Coffman, presiding.
Presentation of building on behalf of Regents—Hon. Fred B. Snyder.
Acceptance—Dean J. B. Johnston and Professor H. A. Erikson.
Dedicatory Address—Professor John Zeleny: "The Place of Physics in the Modern World."

December 1

10:00–12:00 M.
Reading of Papers, Physics Auditorium.

12:00–2:30 P. M.
Drive. St. Anthony boulevard, Memorial Drive, Glenwood, Lake of the Isles to Minnekada Club for luncheon. Continue drive Calhoun, Harriet, Minnehaha, River Road to Laboratory.

2:30 P. M.
Reading of Papers, Physics Auditorium.

SCIENTIFIC NOTES AND NEWS

Thomas Chrowder Chamberlin, emeritus professor of geology in the University of Chicago, died on November 15 at the age of eighty-five years.

William North Rice, emeritus professor of geology in Wesleyan University, died on November 13, at the age of eighty-three years.

It is announced from Stockholm that Nobel prizes in chemistry for 1927 and 1928 have been awarded to Dr. Heinrich Wieland, professor in the University of Munich, and Dr. Adolf Windaus, professor in the University of Göttingen. Both investigators have been engaged in the study of vitamines and have done distinguished work in this and in other departments of physiology and chemistry. M. Henri Bergson, French author and philosopher, is said to have been awarded the prize in literature for 1927, and Mme. Sigrid Undset, the Norwegian authoress, for 1928.

The following awards have been made by the president and the council of the Royal Society: Royal Medals to Professor A. S. Eddington, for his contributions to astrophysics, and to Professor R. Broom, for discoveries which have shed new light on problems of the origin of mammals; the Copley Medal to Sir Charles Parsons, for his contributions to engineering science; the Rumford Medal to Professor F. Paschen, for his contributions to the knowledge of spectra; the Davy Medal to Professor F. G. Donnan, for his contributions to physical chemistry, particularly for his theory of membrane equilibrium; the Darwin Medal to Dr. L. Cockayne, for his contributions to ecological botany; the Sylvester Medal to Professor W. H. Young, for his contributions to the theory of functions of a real variable; the Hughes Medal to M. le Duc de Broglie, for his work on X-ray spectra.

Dr. Herman Schneider, professor of civil engineering, dean of the college of engineering, and now acting president of the University of Cincinnati, has been made an honorary member of the Cincinnati Academy of Medicine.

Dr. Marston Taylor Bogert, professor of organic chemistry at Columbia University, was the guest of honor at the dinner of the Engineering Foundation, New York, on October 18. Professor Bogert has re-

cently accepted the following appointments: associate editor of the *Journal of the American Chemical Society* for a period of five years; member of division of chemistry and chemical technology of the National Research Council for a period of three years; collaborator, bureau of chemistry and soils, U. S. Department of Agriculture, for one year and member of the board of scientific directors of the New York Botanical Garden.

William E. Weiss, of Wheeling, West Virginia, vice-president and general manager of Drugs, Inc., and general manager of the Sterling Products Company, Inc., was the guest of honor at a dinner in New York City on November 13, when he received the degree of doctor of philosophy, *honoris causa,* which was conferred upon him last June by the University of Cologne. The parchment bearing the seal of the university was formally presented by three directors of the university, Dr. Otto Doermer, Dr. Rudolf Mann and Dr. O. Von Hoeffer.

Dr. Raymond A. Dart, professor of anatomy in the University of the Witwatersrand, Johannesburg, has been elected a corresponding member of the Italian Institute of Human Paleontology, Florence.

According to information received by the New York *Evening Post,* in the election for the presidency of Austria neither the government party nor any coalition would result in the necessary two thirds vote for any party politician. Hence a movement is under way to choose a president from among scientific men. Three names mentioned as possibilities are those of Professor Richard Wettstein, botanist of the University of Vienna; Professor Clemens Pirquet, children's specialist and chief of the Vienna Children's Clinic, and Professor Anton Eiselsberg, professor of surgery in the University of Vienna.

Wilber Stout has been appointed state geologist of Ohio, succeeding the late John A. Bownocker. Mr. Stout has been a member of the Geological Survey for seventeen years and is the author of a number of the bulletins of the survey dealing with the stratigraphy and economic products of the Pennsylvanian and Permian systems of eastern Ohio.

Dr. Eugene C. Auchter, professor of horticulture in the University of Maryland and chief horticulturist of the Maryland Experiment Station and the Maryland extension service, has been appointed as a principal horticulturist in the Bureau of Plant Industry to take charge of the newly created office of horticultural crops and diseases. Dr. Victor R. Boswell, associate professor of horticulture in the University of Maryland, has been appointed as a senior horticulturist in the bureau, to have charge of the investigations in vegetable production in the new office of horticultural crops and diseases.

The Chemical Catalog Company has announced the election of Francis M. Turner, Jr., as president. Prior to becoming editor-in-chief for the Chemical Catalog Company Mr. Turner was in the service of the American Vanadium and other corporations, as well as Canadian government commissions. He has been associated with the Chemical Catalog Company since its founding, and became vice-president in 1925.

J. C. Munch, formerly in charge of the federal pharmacological laboratory of the Food, Drug and Insecticide Administration, has succeeded Paul S. Pittenger as director of the Pharmacological Research Laboratories of Sharp and Dohme, Baltimore, Maryland.

John M. Danneker, formerly instructor in chemistry at Tulane University, was recently appointed city chemist by the Commission of the City of New Orleans.

Dr. P. J. Kelly, surgeon-general of British Guiana, has been nominated a member of the legislative council of British Guiana and a member of the executive council of the colony.

Dr. W. V. King, of the Bureau of Entomology, who has been engaged in mosquito work at Mound, Louisiana, has an appointment from the International Health Board to visit the Philippine Islands for the purpose of making a special study of mosquitoes in the islands. He expects to spend several months in the islands and will bring his material to the museum for final study in conjunction with Dr. Harrison G. Dyar.

A meeting of the committee on electrical insulation of the National Research Council was held at the Johns Hopkins University on November 15, 16 and 17. The sub-committee on physics includes the following members: Professor Vladimir Karapetoff, *chairman,* Cornell University; Mr. Ernest G. Linder, *secretary,* Rockefeller Hall, Ithaca, New York; A. A. Bless, University of Florida; Professor A. B. Carman, University of Illinois; Professor A. H. Compton, University of Chicago; Professor K. T. Compton, Princeton University; Dr. H. L. Curtis, Bureau of Standards; Professor Wheeler P. Davey, Pennsylvania State College; Professor O. S. Duffendack, University of Michigan; Dr. C. F. Hill, research department, Westinghouse Electric and Manufacturing Company; Professor S. C. Lind, University of Minnesota; Professor L. B. Loeb, University of California; Dr. G. M. J. Mackay, research laboratory, General Electric Company; Dr. F. B. Silsbee, Bureau of Standards; Professor Harry D. Smythe, Princeton

University; Dr. T. S. Taylor, Bakelite Corporation, Professor J. B. Whitehead, the Johns Hopkins University.

Dr. Edwin R. Embree, president of the Julius Rosenwald Fund, announces that it is planned to extend the work of the fund, heretofore chiefly concerned with building negro rural schools, to include support of medical services to people of moderate means. Michael M. Davis, Ph.D., has been appointed to the executive staff of the fund as director for medical services. He will direct the program which the fund is planning to undertake in cooperation with the medical profession to improve the organized facilities for medical service to the average man. Special attention will be given to pay clinics. William B. Harrell, now assistant auditor of the University of Chicago, has been appointed secretary and comptroller. Clark Foreman, a graduate of the University of Georgia, who is now with the Phelps-Stokes Fund of New York, has been appointed associate field agent for southern schools and colleges. Dr. Franklin C. McLean, chief of the medical clinics of the University of Chicago, has been elected a trustee.

The non-resident lecturer in chemistry at Cornell University under the George Fisher Baker Foundation, for the second term of the academic year 1928–1929, will be Professor F. M. Jaeger, of the University of Groningen, Holland. In his lectures Professor Jaeger will discuss two topics, "Symmetry and Optical Activity of Atomic Configurations" and "Methods, Results, and Problems in High Temperature Precision Measurements." His lectures will begin on February 14.

Professor W. A. Noyes, of the University of Illinois, recently made a lecture tour during which he spoke on "Valence" before sections of the American Chemical Society at St. Louis, Manhattan, Kansas, and Kansas City.

On November 13, Dr. W. F. G. Swann, director of the Bartol Foundation of the Franklin Institute, addressed the Swarthmore College Chapter of the Society of Sigma Xi on "The Work of the Bartol Research Foundation."

The annual Gross lecture of the Pathological Society of Philadelphia was delivered November 8 by Dr. Arnold R. Rich, associate professor of pathology, the Johns Hopkins University School of Medicine, Baltimore, on "The Rôle of Allergy in Tuberculosis."

Dr. Hrdlička delivered a lecture on November 5 on "The Where, When and Why of Human Evolution" before the Section of Geology and Mineralogy of the New York Academy of Sciences.

The Lloyd Roberts lecture on Faraday's diary will be delivered by Sir William Bragg at the Royal Society of Medicine, London, on November 29.

Dr. F. G. Banting, of the University of Toronto, gave the Cameron lecture at the University of Edinburgh on October 30, giving a historical account of the researches that led to the discovery of insulin.

The first Liversidge lecture before the Chemical Society of London, entitled "Physical Chemistry in the Service of Biology," will be delivered by Professor F. G. Donnan on November 29.

During the week beginning November 19 a series of lectures was given at Vassar College under the auspices of the biological departments, botany, physiology and zoology. This is in accordance with a custom at Vassar to devote two or three times a year one week to lectures under the auspices of two or more allied departments. The first such series was given in the fall of 1926 in connection with the opening of the Sanders Laboratory of Physics. The speakers and subjects were as follows: November 19, Dr. W. Mansfield Clark, the Johns Hopkins University, "Life without Oxygen"; November 21, Dr. Wm. Crocker, Boyce Thompson Institute of Plant Research, "Research with Plants"; November 21, Dr. George H. Parker, Harvard University, "Organization of the Nervous System"; November 22, Dr. John M. Coulter, Boyce Thompson Institute of Plant Research, "The Present Status of Evolution"; November 23, Dr. Robert Chambers, New York University, "Our Knowledge of Protoplasm as Obtained by the Microdissection Method"; November 23, Dr. Abby H. Turner, Mt. Holyoke College, "Harvey and the Circulation after Three Hundred Years."

On November 19, 20, 21, 22 and 23, Professor H. B. Williams, director of the department of physiology of the College of Physicians and Surgeons, Columbia University, delivered the third annual Priestley Lectures at Pennsylvania State College. The topic of his course of lectures was "Method in Scientific Investigations." The Priestley Lectures deal each year with the borderline between physical chemistry and some other branch of science. The first year's lectures dealt with the borderline between physical chemistry and bio-colloids and were given by V. Cofman, of the Experimental Station of the E. I. du Pont de Nemours and Company. The second year's lectures on the borderline between physical chemistry and

metallography were given by Dr. S. L. Hoyt, of the Research Laboratory of the General Electric Company.

DR. ALEXANDER ZIWET, professor of mathematics at the University of Michigan, died on November 18, at the age of seventy-five years.

SIR HUGH KERR ANDERSON, F.R.S., master of Gonville and Caius College, Cambridge, has died at the age of sixty-three years. Sir Hugh was elected a fellow of the Royal Society in 1907 for his researches on the physiology of the nervous system.

THE death is announced of Professor Luigi Sabbatani, of the chair of pharmacology in the University of Padua.

R. A. BERRY, professor of agricultural chemistry at the West of Scotland Agricultural College, Glasgow, died on October 12, aged fifty-two years.

CORNELL UNIVERSITY has been chosen for the meeting of the sixth International Congress of Genetics in August, 1932. At the last meeting of the congress, held in Berlin in 1927, it was voted to hold the sixth meeting in the United States. Dr. C. B. Davenport, in charge of the Carnegie Station for Experimental Evolution, and Dr. T. H. Morgan, of the California Institute of Technology, were appointed a committee to determine the place of meeting. This will be the third international scientific convention to be held at Cornell in recent years. The other two were the International Congress of Plant Sciences in 1926 and the International Congress of Entomology, which was held during the past summer.

THE Iowa Academy of Science will hold its annual meeting in April at Parsons College, Fairfield, Iowa.

A BALNEOLOGICAL Congress will be held in Berlin from January 25 to 27, this being the fiftieth year since the foundation of the German Balneological Society. Details may be obtained from the general secretary of the congress, Fraunhoferstrasse 16, Charlottenburg, Germany.

THE International Conference on Economic Statistics of the League of Nations will open in Geneva on November 26. The American representatives include: Dr. E. Dana Durand, chief of the division of statistical research, Department of Commerce, as delegate; Asher Hobson, of the permanent committee of the International Institute of Agriculture, and James F. Dewhurst, chief of the statistical division of the Federal Reserve Bank of Philadelphia.

THE *Journal* of the American Medical Association reports that, under the patronage of the king, with Mr. Chamberlain, minister of health, as president, a public health congress and exhibition will be held in London in November. Addresses will be given by Sir George Newman, chief medical officer of the ministry of health, on the purpose of the public health services; by Sir Walter Fletcher, secretary of the Medical Research Council; by Mr. Wilfred Buckley, a member of the milk advisory board, on the production and distribution of wholesome milk, and by Dr. W. M. Willoughby, health officer of the city of London, on food protection from the national and domestic standpoints. Water supply and sewerage, the construction and equipment of hospitals and town cleansing are other subjects. The congress will last for a week.

THE president of the Board of Education of Great Britain has appointed a committee to advise as to the scope and methods of the board's inquiry into technical education for the engineering industry, and to review the material furnished to the board in the course of the investigation. Sir Dugald Clerk is chairman of the committee and Mr. H. B. Wallis will act as secretary. All communications should be addressed to him at the office of the Board of Education, King Charles-street, Whitehall, London, S. W. 1.

THE Office International d'Hygiène Publique, Paris, has entered into an agreement with the Health Committee of the League of Nations to avoid overlapping in work; this and several similar agreements have resulted in the establishment of a world-wide system of immediate intelligence regarding the prevalence of cholera, plague, yellow fever, small-pox and typhus. Consideration has been given to proposals for unifying quarantine flags and signals, and for establishing an annual international record of the sanitary equipment of seaports, and like matters.

DR. L. C. GRAY, in charge of the division of land economics, Bureau of Agricultural Economics, returned from Rome on November 2, where he and Asher Hobson served as delegates of the United States in the general assembly of the International Institute of Agriculture. Mr. Hobson is permanent delegate of the United States to the institute. Dr. Gray reports that the assembly passed practically all the resolutions in which the American delegation had special interest. Resolutions were passed providing for changes in the statutes, and in the policy of the permanent committee looking toward a larger measure of international control and a greater degree of centralization of administration, which, it is believed, will result in greater efficiency in the operation of the institute. Resolutions were passed directing the administration of the institute to put greater emphasis on its work

of collecting and transmitting statistics on crops and livestock and livestock products by cable, and providing for promoting the use of standard methods in collecting statistics in the various countries, and for the development of standard index numbers of prices, production, factors of expenses and net income.

A PRELIMINARY statement by the British Ministry of Agriculture relating to the World Poultry Congress in 1930 has been issued. The Crystal Palace has been made headquarters of the congress. The Ministers of Agriculture for England and Wales and Northern Ireland, and the Secretary of State for Scotland will be presidents of the congress; Mr. F. C. Elford (Canada), president of the International Association of Poultry Instructors and Investigators, will be first vice-president, with Lord Dewar and Dr. Edward Brown, vice-presidents. Invitations have been sent to the National Farmers' Union and to the National Poultry Council for their respective presidents to become vice-presidents of the congress. The congress will open on July 22 and close on July 30, 1930, following which a series of tours will be arranged, covering the whole of the British Isles. The Crystal Palace will accommodate the international display of live stock, and practically the whole of the lecture sessions and business meetings will be held there during the congress. The Ministry of Agriculture recognizes that the success of the congress depends to a large extent upon the whole-hearted cooperation of all sections of the poultry industry, and a gratifying response has already been made by the enrolment of a large number of voluntary workers upon the following committees and sub-committees: General purposes, congress building, live stock, education, papers and sessions, press and propaganda, trade exhibits, transports and entertainment and visitors' accommodation and reception, while a woman's committee will subsequently be formed. The director of the congress will be Mr. P. A. Francis, and the secretary Dr. V. E. Wilkins, of the Ministry of Agriculture.

THE Department of Scientific and Industrial Research has published the thirteenth report on the investigation of atmospheric pollution; this is in continuation of the series of reports of the Advisory Committee on Atmospheric Pollution, hitherto issued by the Meteorological Office, the change following upon the transfer to the Department of Scientific and Industrial Research of responsibility for the government's share in the work. The *British Medical Journal* states that the Advisory Committee will become a standing conference of cooperating bodies. In the report the deposit of impurity at 80 different stations in the United Kingdom is considered; a classification is made according to standards of increasing quantity of deposits, this being denoted by the letters A to D in order of quantity of pollution. It is satisfactory to note that there has been a substantial improvement in atmospheric purity in the areas covered; in 1914-1915 the number of stations ranking as A and B was 54 per cent. of the total; in the year under review the number was 87 per cent. of the total. A steady decrease in the quantity of sulphates deposited in London and Glasgow has been observed, and it is stated that this is, as least in part, due to the increasing use of coal gas, this having presumably replaced raw coal. The tables included in the report give details month by month of the deposits collected at the various stations, showing wide variations in their composition. A section dealing with suspended smoky matter in the air illustrates the effect of the coal stoppage of 1926, while the obstruction of ultra-violet radiation by smoke is brought out by a curve which indicates that nearly the whole of the ultra-violet rays is cut off by a comparatively small amount of smoke in the air. Much of the matter contained in this slim volume—it contains less than sixty pages—is of considerable scientific interest, and should be of some practical value to those engaged in public-health work, but its publication at the net price of 6s. 6d. will not encourage a wide circulation.

UNIVERSITY AND EDUCATIONAL NOTES

A GIFT of $100,000 has been made to St. Lawrence University from S. L. Carlisle and Company of New York City. A letter from the company, made public by Dr. Sykes, stipulated that the gift was to be payable at the rate of $20,000 a year for five years and was to be used by the university to promote the teaching of forestry, although its use was not restricted to the formal teaching of that subject in the school.

THE Institute of Mathematics and Applied Mathematics of the University of Paris, dedicated to the memory of Henri Poincaré, was opened on November 1, with ceremonies presided over by Premier Poincaré. The money for building the new institute was provided by Baron Edmond de Rothschild and the International Education Board, which also subscribed $18,000 for the founding of a chair of applied mathematics. The new building contains two lecture halls capable of seating 200, and also 100 students' offices and studies on the ground floor, a library on the second floor and display rooms for astronomical and geometrical models on the third floor.

JULIUS ROSENWALD has pledged a contribution not to exceed $5,000 for a period of five years for the purchase of books, periodicals and other scientific publications for the medical library at the University of Chicago, the yearly contributions to match what-

ever sums are contributed from other sources up to the amount of the pledge.

DR. TORALD SOLLMANN, professor of pharmacology at Western Reserve University, has been appointed dean of the school of medicine. He succeeds Dr. Carl A. Hamann, whose request that he be permitted to resign was regretfully acceded to by the trustees.

THORNE FITZ RANDOLPH has resigned his position as assistant principal and instructor in chemistry in the Franklin High School to accept a position as professor of chemistry in charge of the chemistry department of the Indianapolis College of Pharmacy, Indianapolis.

DR. HAROLD B. FRIEDMAN, instructor at the University of Maine during the past year, has been appointed research assistant in chemistry at Columbia University for the coming year.

C. A. HOPPERT, research chemist for the Soft Wheat Millers Association, has become associate professor of biological chemistry at the Michigan State College.

ERNEST VICTOR JONES, formerly science adviser and professor of inorganic and physical chemistry at the University of Nanking, China, after spending a sabbatical year at the University of California, has accepted the position of head of the department of chemistry at Birmingham-Southern College, Birmingham, Alabama.

DISCUSSION AND CORRESPONDENCE

PHYSIOLOGY AND MEDICINE

THE address of Professor C. A. Lovatt Evans on the "Relation of Physiology to other Sciences,"[1] delivered before the section on physiology of the British Association for the Advancement of Science this summer at Glasgow, presents questions of very great interest, especially to me, from the point of view of the relation of physiology to medicine, that is to say, to the study of disease. Professor Evans has in general adopted very liberal and on the whole just views of the relations of physiology and medicine. His address was concerned with this particular relation as one only of the many intellectual contacts of physiology with the world of science. But it is a relation which has occasioned much discussion in times past, and still continues to do so; one furthermore about which there is yet no unanimity of opinion, either in the United States or elsewhere. In England, especially, traditional views have regarded the position of medicine in a scheme of knowledge to be somewhat different from the one which is now held by the Medical Units in London and elsewhere in the United Kingdom at least in part, and certainly by three university clinics in the United States, at Harvard, Chicago and Cornell, and at the Rockefeller Institute in New York. If I single out this subject for discussion from among the many interesting ones about which Professor Evans spoke, I do so because I believe this issue is still unsettled and important and because I think something is to be gained in the interests of the general understanding of the problem by directing attention to it again.

The prevalent view in the United States is that one of the great functions of the university clinic is the effort to get on with enlarging and deepening knowledge of disease. We believe that the person most likely to do this is the person who has elected this to be the great interest of his life and work. The meaning of what has been so badly labeled the full-time position exists, in the view at least of three of the institutions just mentioned, for the purpose of affording opportunity to devote themselves to this end on the part of those professors of medicine who accept their posts with the awareness that this is at least one of the great purposes of their calling. Those professors who adopt this interpretation of their posts must necessarily adopt also, perhaps not always consciously, a definition of medicine, meaning by medicine in this particular instance the study of disease.[2] They wish to be so trained and so to train those students who elect to follow in their scientific footsteps as to master whatever technique, whether physical, chemical, physiological or immunological, is necessary in order to advance their pursuit. They are in no other situation in this regard than professors of biology or physiology or of any other scientific discipline. Nor are they under any illusion concerning the difficulty of their undertaking.

Their attitude toward the study of disease is, it seems, different from that which Professor Evans assumes or at all events discusses. I believe that in his remarks there is failure to distinguish between persons and disciplines. A discipline, conceptually, is a unit conditioned by its subject-matter; its unity does not depend on what the training and antecedent interest are of the person who cultivates it. It may very well be that an anatomist or a physiologist may work at disease or that for reasons of his own a physician may study anatomy or physiology. That is his own affair and does not concern the logical structure of the sciences. Some of us in America have appre-

[1] SCIENCE, 1928, 68: 259–264 and 284–291.

[2] This definition is discussed at length in my paper, "Medicine and Science," *Journal of Philosophy*, 1928, xxv: 403, and need not be elaborated here.

ciated the fact, or think we have, that there is advantage in facing this issue. We have accordingly provided the means for making it possible in each discipline, including medicine as the study of disease, or pathology, to use the English designation, to bring discipline and person together. He who is interested in anatomy may, and usually does, profess anatomy; he who is interested in physiology may, and usually does, profess physiology; he who is interested in disease may and, if we are to get on with knowledge of it, should profess medicine.

Professor Evans is well aware that medicine is the mother of the sciences. He knows how chemistry, anatomy and physiology all had their inception in the world's general interest in disease. So they began. They grew and soon conquered provinces of their own. That is the meaning of the separate institutes these disciplines now so often possess. But now, although physiology has made itself independent, Professor Evans still harbors fears. He fears to cut the guiding strings of the alma mater, lest physiology lack nourishment. And like many, especially modern, children he fears lest the ancient mother be too feeble intellectually and too powerless, having reared and weaned her children, to be able to continue to order and to develop her own house. But the situation is just this: having learned as it were and indicated to her many offspring how they might best set up houses of their own, medicine is at length free to cultivate her own garden. In America in a tentative and prayerful way, despite many hardships and much misgiving, we in medicine are at work upon our proper domain—proud meanwhile of the children of medicine and when we require it, as naturally we often do, eager for their support. But we want to be so equipped ourselves as to be able to cultivate our own garden. What we mean by this is that the idea is dawning that the study of disease is, or may be, something not necessarily coextensive with practice; that it may be pursued as a phase of disinterested learning. There is in short a difference between the practice of medicine and the academic study of disease just as there is a difference between academic physics and practical engineering. Both interests are essential; both have legitimate human value, though they engage the attention of individuals differently equipped.

Professor Evans believes that "the physician's duty with regard to it [disease] is a threefold one: he must diagnose, prognose and treat." And concerning the "two important principles" of treatment he has this to say concerning the support medicine receives from physiological knowledge:

> One is that the consequential alterations which take place in the course of the disease are of the nature of adaptations which tend to restore the function to normal; these adaptations take the form of increase or diminution of some particular factor, of hypertrophy or atrophy often of some definite organ, always of some function—it is, in fact, the *Vis medicatrix* of the older physicians, the underlying principle of expectant treatment. The other principle is that nearly all positive measures of treatment, including drugs, produce their effects by augmenting or restricting some function or other.

This undoubtedly is one way of regarding the happenings in a diseased body. But may not another one also be urged, one which has indeed been urged by me in the paper to which I have referred. The view which is there taken is that a disease, instead of being merely a quantitative deviation from health, is a collection of new phenomena, a new complex, and is sufficiently different to be regarded as a qualitative change. Whitehead has illuminated this point of difference between quantity and quality when he says that "In the past human life was lived in a bullock cart; in the future it will be lived in an aeroplane; and the change of speed amounts to difference in quality." So it is in disease. And if this is so, whose business is its study so much as it is that of the physician devoted to this pursuit, in our case the university professor of medicine, whose it has always been since there have been university professors, and who brings to its contemplation his undivided interest?

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PRELIMINARY NOTE ON THE LIFE HISTORY OF HYMENOLEPIS CARIOCA

EXPERIMENTS on the life history of *Hymenolepis carioca* have established in a preliminary way that one of the dung beetles, *Aphodius granarius,* serves as an intermediate host. Beetles fed with eggs of this tapeworm developed cysticercoids in the body cavity and tissues, and when such infected beetles were fed to chicks some of these birds showed the presence of *H. carioca* ante mortem and post mortem; control birds under the same conditions but not fed infected beetles remained free from all helminths.

Previous studies in the published literature report the development of this tapeworm in chicks fed wild stable flies presumably naturally infected, but in these experiments larval stages were not found and the evidence that the stable fly is a host is incomplete. The results reported here are important in view of the work based on results from feeding wild insects to chicks kept in fly-proof cages, or attempts to raise chickens free from tapeworms by using screened enclosures, since such small beetles as

Aphodius are capable of passing through a screen that will keep out flies. A complete account of the experiment will be published elsewhere.

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THE WORD CARIBOU

WITH respect to the etymology of the word *caribou* as given by Professor L. B. Walton in SCIENCE of October 12, it may be well to show the aboriginal origin of the term by quoting the late Dr. A. F. Chamberlain's brief article on the subject in the "Handbook of American Indians."[1]

> The word came into English from the French of Canada, in which it is old, Sagard-Théodat using it in 1632. Josselyn has the Quinnipiac form *maccarib* and the synonym *pohano.* The origin of the word is seen in the cognate Micmac *χalibu* and the Passamaquoddy *megal'ip,* the name of this animal in these eastern Algonquian dialects. According to Gatschet (Bull. Free Mus. Sci. and Art, Phila., II, 191, 1900) these words signify "pawer" or "scratcher," the animal being so called from its habit of shoveling the snow with its forelegs to find the food covered by snow. In Micmac *χalibu' mul-χadêget* means "the caribou is scratching or shoveling."

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QUOTATIONS

AWARD OF THE NOBEL PRIZE TO DR. CHARLES NICOLLE

THE recent announcement in the daily press that Dr. Charles Nicolle, director of the Pasteur Institute of Tunis, has been awarded the Nobel prize for medicine for 1928 in recognition of his work on typhus fever will be a source of gratification to all interested in the progress of medicine and to epidemiologists in particular. Dr. Nicolle's researches on the causation and prophylaxis of typhus, which have been carried on for nearly a quarter of a century, were first undertaken in connection with an epidemic which occurred in Tunisia in 1906–9, when he was able to show that the chimpanzee could be infected with the typhus virus by the injection of a small amount of blood from a patient in the acute stage of the disease. Subsequently he found that the lower apes could be similarly infected by inoculation of the blood of the chimpanzee, and that the infection could be transmitted from monkey to monkey by the bites of infected body lice. The demonstration of the louse as the agent in transmitting the disease was of far-reaching importance, and, like Dr. Nicolle's other investigations, it was confirmed by workers in the United States and in other countries. Dr. Nicolle also found that the guinea-pig could be successfully inoculated by injection of typhus blood. Although this animal showed no sign of disease as the result of inoculation except by a rise of temperature, it served a useful purpose in forming a storehouse of the virus for laboratory purposes. Of greater practical importance was Dr. Nicolle's discovery that injection of the serum of patients convalescent from typhus was able to confer an immediate though transient immunity to the disease. A similar protective quality in the serum of convalescents he also showed to be present in the case of undulant fever and also in that of measles some years before Degkwitz made the method popular throughout Germany. One of his latest contributions indicates that Dr. Nicolle, in collaboration with Drs. Sparrow and E. Conseil, is conducting experiments on active immunization against typhus whereby a more permanent immunity can be conferred. In addition to his article on typhus written in conjunction with Dr. E. Conseil in the "Nouveau Traité de Médecine" of Roger, Widal and Teissier, Dr. Nicolle is the author of numerous contributions on infectious diseases, including measles, influenza, chancroid and undulant fever.—*The British Medical Journal.*

[1] *Bulletin 30, Bureau of American Ethnology,* pt. 1, p. 206, Washington, 1907.

SCIENTIFIC BOOKS

Astronomy and Cosmogony. By SIR J. H. JEANS. Cambridge University Press, 1928.

THERE are some chapters in modern astrophysics which can hardly be easily digested by a mind trained in a rigorous spirit of classical astronomy and celestial mechanics. It is quite evident that in order to throw light on the enormous amount of astrophysical data accumulated within the last twenty years we have to penetrate mentally into the interiors of the stars and to draw a picture of stellar material, *i.e.,* matter in conditions of enormously high pressure and temperature. In applying here the physical laws and principles deduced and checked in the conditions of our "low pressure and temperature" environment we are certainly using a very dangerous extrapolation, thus violating the policy of the exact sciences. We use mathematical physics—that miraculous star boring and drilling machine—under the tacit assumption that this extrapolation is allowed by the general principle of uniformity and continuity of physical laws in

space and time; this principle has never failed; on the contrary it has proved exceedingly useful in all branches of cosmical physics.

On the other hand, in several instances the results of our analysis of stellar interiors can be checked by observing phenomena on the surfaces of the stars, and whenever this possibility is available it has always brought the verification of the theoretical results (at least in general terms). We remember, for example, the beautiful discovery of the relativity shift in the spectrum of the companion of Sirius, which confirmed one of the strangest conclusions of theoretical astrophysics—the possibility of matter in stellar interiors having a fantastically high density and still preserving its gaseous properties.

These two lines of argument—the principle of uniformity and continuity of the most important laws of nature and some data of observation—seem to show that in our study of the stellar interior we are, generally speaking, following the right way of reasoning, however dangerous it is from the standpoint of the exact sciences. This path is a very narrow one, and a student of theoretical astrophysics is always on the verge of disaster—with one incautious movement the scientific work turns out to be an unfruitful speculation and the investigator himself is hopelessly lost pursuing the ghosts created by his own imagination; and mathematics, no matter how perfect it is, can not help him—it is only the intuition of a physical truth which may get him on the right path.

Sir J. H. Jeans, one of the leading scientists of our times, has recently published a new voluminous book on theoretical astrophysics, embodying in a full and systematic manner his long and varied researches in this field. Sir J. H. Jeans is one of the founders of theoretical astrophysics, and has contributed many fertile ideas and theories to the new science. His new book is therefore of unusual interest to every student of astronomy. Some chapters of the book under review, dealing with the figures of equilibrium of rotating liquid and gaseous masses, are merely the revised reprints from his first book, "Problems of Cosmogony and Stellar Dynamics," published in 1919, but others deal with more modern problems: the sources of stellar energy, liquid stars, variable stars, stellar evolution and extragalactic nebulae. Every student of astrophysics who has followed astronomical journals during the last few years is of course more or less familiar with Jeans's theories, his polemics with Eddington, and the rapid—sometimes unexpectedly rapid—development of his ideas. But even for such a reader it is of considerable interest to see those theories expounded anew in a corrected, improved and (so to speak) codified form. Some of the new chapters are especially attractive and stimulating, for instance, Chapter X dealing with Jeans's beautiful discovery of radiative viscosity and his work on the rotation of stellar interiors, which gives seemingly a final and very simple explanation of the equatorial acceleration of the sun—a puzzling problem, which for many years did not yield to the most refined methods of modern hydrodynamics. This chapter certainly opens a new field for theoretical research and appears to be one of the most important and lasting of Jeans's contributions to exact science.

Reading thoroughly the numerous masterly pages we can hardly avoid the conclusion that Jeans's book depicts a system of astronomy and cosmogony which (as it has been in the case of all great philosophical systems) lives, stands or falls with one central idea—the real soul of most of his investigations. This is an idea of super-radioactivity of stellar matter creating energy, independently of the temperature and pressure, by the annihilation of protons and bound electrons. If stellar matter really has this fundamental property, we have to choose a stellar model which will allow of a high atomic weight. For any adopted value of the effective molecular weight μ of stellar matter, Jeans's theory affords a possibility of computing the value N^2/A (N = atomic number, A = atomic weight) for different stars built according to his model. Operating with $\mu = 2.5$ he shows (p. 98) that the mean of N^2/A for nine selected stars is equal to 300, which gives an extremely high value for the atomic weight A. On account of this we have to change the initial value of μ; then as a second approximation we get another still higher value of A, which demands a new increase in μ and so forth, and "it is impossible to say whether this race will stop or not." It is evident therefore that the solution is divergent—badly divergent—and that under such circumstances no result can be reached until we try initial values of μ, or other models, or finally change the coefficient for the opacity law. (It might be of interest to note that for dwarf stars we can get a convergent solution, even using Jeans's numerical data and star model. For example, the two components of Krueger 60 give for $\mu = 2.0$ a convergent value $N^2/A = 10_{02}11$ and pure calcium appears to be quite a suitable building material for these dwarfs.) Anyhow it is hard for a mathematician as well as for a physicist to accept Jeans's high values of the atomic weight of stellar matter.

Another point of extreme importance in Jeans's investigations is his theory of the stability of the stellar structure (Chapter IV). If his deductions are correct a star built up of any material that is not super-radioactive will necessarily be very fragile; even

small perturbation is sufficient to crush such a star out of existence; it is condemned to death from the first day of its life. The question seems to be one of extreme difficulty—a simple and beautiful theory of stability of mechanical systems is no longer sufficient; we have to investigate the thermodynamic stability by considering various physical factors affecting it. Jeans was the first who investigated this question mathematically, but it seems to me that here as in the former case he took a *regia via*. For instance he did not take into account the ionization energy of a star and the effect of viscosity in the more general case of vibration. Now it is evident that inside an atom and outside the nucleus we have (taken for the whole star) an enormous amount of stored energy—the energy of bound electrons—which is very easily tapped and locked by an ordinary mechanism of ionizations and captures. This storage of energy might be fatal for stability, but in some cases it may save a star from death, as everything depends upon the atomic properties of the stellar material. We may expect that in such a manner not only dwarfs but also ordinary giants may be rescued, while the question of the abnormally massive star still remains open.

These critical notes certainly can not diminish the value of Jeans's well-known contributions to astronomy: his general theory of the stellar interior, the theory of double stars, moving clusters, etc., have to be considered as the most important starting-points for future investigators. It is a real pleasure to look over again and again these masterly pages, to enjoy their mathematical elegance, forgetting for a moment that for their author they are merely subordinate parts of his "system."

Of prime importance are the pages (323–352) dealing with extragalactic (formerly "spiral") nebulae, where Jeans applies his old theory of gravitational instability to Hubble's new data on these "island universes." For Jeans the central "unresolved" parts of the spirals are something like white dwarfs of enormous size, where the atoms are as closely packed as in the interior of the companion to Sirius. The motions in spiral arms still remain unexplained on the basis of Newton's law.

Certainly "Astronomy and Cosmogony" is one of the most "personal" books on astronomy ever written. Theories and data, no matter how important, are not even mentioned if they are for one reason or another not interesting to the author. In the chapter on the Galactic system, the new and very conclusive results on the Galactic rotation are simply neglected, and the reader will be unable to find any reference to Lindblad's or Oort's work. It might be curious to note the character of data as quoted by Jeans in his book; he uses, for example, the very old data of Kepler on the velocity of planetaries (p. 27); statistical data on all kind of binaries are taken from a book published in 1918 (p. 282, etc.), and accordingly Polaris still is supposed to have a long spectroscopic period of twenty years (p. 305).

We may get great pleasure and benefit from studying a scientific book without being convinced by its author. We can not agree with Jeans's opinion on the structure of the stars, but we are delighted by the vigor and freshness of his ideas as well as by the elegance of his mathematics and his arguments. He takes the reader to the top of a high mountain and shows him an enormous perspective of the universe in space and time. The reader may doubt whether the distant objects he sees from above are really what his guide represents them to be, but he is indebted to him for an unusual and stimulating feeling of grandeur and exhilaration.

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

THE USE OF FRESH PIG OVARIES IN THE EMBRYOLOGICAL COURSE

BECAUSE of the abridgment of the anatomical discipline growing out of the prevailing reorganization of the medical curriculum, and the consequent abandoning of certain laboratory exercises that had well-nigh become traditional, their place to be taken by more concise methods, the following brief suggestion relative to an introductory experiment in the course in human or mammalian embryology may be permitted. For a long time the simplicity of the idea underlying it deterred the writer from making formal allusion to it, but a trial of several years has proved its fitness to be brought to the attention of instructors elsewhere who might wish to utilize it—if they have not already done so—in the student's initial experience in that work.

It was while the members of a class were led to observe the several morphological phases of the corpus luteum in fresh pig ovaries, secured in considerable number from the abattoir, that the thought naturally presented itself of directing them also to open the larger unruptured follicles, to search for the cumulus with the aid of hand lens, and then to remove it for the microscopic examination of the egg and the adherent follicle cells. By carefully excising the large intact follicle and suddenly puncturing it on the slide, the egg cell may in many instances be easily dislodged and extruded. Operations and observa-

tions of this kind not only impress the student with such characteristics of the mammalian ovum as its diminutive size, for example, or with the image of its fresh state, which differs so effectively from the visions of the fixed and colored tissue that dominate the morphological imagination, but also bring him more concretely into contact with the physiological process of ovulation. True, the technical difficulties involved in the mastery of the exercise will register many failures in a large class, but the interest which it arouses, the ingenuity it calls into play and the competition which it engenders, all combine to make it a stimulating introduction to the embryological course.

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EASY SAMPLING OF PLANT TISSUE

THE usual procedure in preparing green plant tissue for sampling for chemical analysis has been to cut the material into one half to one inch segments with a razor or sharp knife. In some instances scissors have been used when the material has not been too bulky or tough. Obviously the preparation of material by this procedure has been a laborious task when the material has been very hard and fibrous or the amount of tissue was very large. In fact, the labor involved is so great that it has been practically impossible to secure samples for analysis when the bulk of material has been large.

Recently in this laboratory some samples of one hundred plants each of hubam clover were taken for carbohydrate studies, but because of the woodiness of the stems it was practically impossible to secure samples for analyses by the procedure mentioned above. The stems were so woody that they were chopped with difficulty with a sharp corn knife.

A paper-cutter having a ten-inch blade was tried and found to work very successfully. The samples of one hundred plants were cut into one half to three quarter inch segments in from three to five minutes. The paper-cutter has been tried on other material and has been used almost exclusively in preparation of green plant tissue for analyses. Samples of cowpeas weighing ten pounds have been prepared for sampling in ten minutes. Fibrous stems like those from large tomato plants have been prepared for sampling in a few minutes.

While the use of a paper-cutter for preparing samples may not be new to a number of laboratories, there are so many places in which the razor method is used that a suggestion to use a paper-cutter in the preparation of samples may be very helpful.

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SPECIAL ARTICLES

THE LEAKAGE OF HELIUM THROUGH PYREX GLASS AT ROOM TEMPERATURE

(Contribution from the T. Jefferson Coolidge, Jr., Memorial Laboratory, Harvard University.)

IN experiments upon the change in PV with pressure for helium at 0° C. in a container of Pyrex glass it was noted that even in so short a time as twenty-four hours the alteration in PV at atmospheric pressure through leakage of helium was perceptible. In Table I are given the products of the pressures in millimeters by the volumes in milliliters as determined on different dates. Since the pressure was considerably below atmospheric in the second series of experiments, in which the gas was expanded from 319 ml. to 392 ml., there can be no question of mechanical leakage. Furthermore the apparatus had been used previously for argon and showed no similar effect.

TABLE I

Date	P	PV	Time	dPV	Change per day
	mm.		days		Per cent.
Oct. 15, 1927	770	245513			
Oct. 18	"	245485	3	28	0.0038
Oct. 20	"	245470	5	43	0.0035
Oct. 23	"	245444	8	69	0.0035
Oct. 25	627	245418			
Oct. 29	"	245388	4	30	0.0031
Nov. 2	"	245373	8	45	0.0023

The capacity of the container in the first series of experiments was 319 ml., the interior surface about 257 cm^2, and the thickness of the walls, which were not very uniform, between 1.5 and 2.0 mm. Apparently the leakage per day per cm^2 was 0.04 mm^3.

Although the leakage of helium through Pyrex glass at elevated temperatures has been noted by various observers, we have been unable to find any reference to this effect at ordinary temperatures.[1] In order to make sure that what we observed was really diffusion through and not merely into glass we have made a roughly quantitative determination of the rate at room temperature in the following way: A spherical Pyrex glass globe of 1044 ml. capacity was filled with fairly pure helium to a pressure of 75 cm. at 20°, and then was sealed by fusion of the glass. A counterpoise of 1.4 ml. greater exterior volume than that of the globe was filled with argon at 79 cm. and also carefully sealed. Since the coun-

[1] Paneth, Peters and Günther state that glass dissolves more helium than neon at ordinary temperatures. *Ber.*, 60B, 808, 1927.

terpoise was heavier than the globe by 8 g. (brass), the effective volume of the globe and weights was 0.4 ml. less than that of the counterpoise.

The difference in weight between the two was then very carefully determined at intervals over a period of twelve months. In making the comparisons the globe and counterpoise were similarly treated preparatory to weighing and were suspended on opposite sides of a sensitive balance in a room maintained at nearly constant temperature throughout this time. The observations follow:

Date	Excess in weight of counterpoise over globe	Time	Loss in weight	Loss in weight per day
	g.	days	mg.	mg.
Nov. 11, 1927	8.08873			
Nov. 12	8.08875	1	0.02	0.02
Nov. 15	8.08876	4	0.03	0.007
Nov. 21	8.08882	10	0.09	0.009
Nov. 29	8.08886	18	0.13	0.007
Dec. 6	8.08890	25	0.17	0.007
Dec. 15	8.08893	34	0.20	0.006
Dec. 21	8.08896	40	0.23	0.006
Jan. 21, 1928	8.08916	71	0.43	0.0059
Feb. 8	8.08925	89	0.52	0.0059
Mar. 1	8.08939	111	0.66	0.0059
May 7	8.08958	178	0.85	0.0048
May 30	8.08965	201	0.92	0.0046
June 26	8.08975	228	1.02	0.0045
July 25	8.08996	257	1.23	0.0048
Oct. 23	8.09036	347	1.63	0.0047
Nov. 2	8.09040	357	1.67	0.0047
Nov. 11	8.09046	366	1.73	0.0047

Although the loss in weight per day at first shows a gradual diminution with the time, it is possible that a part or even most of this diminution is due to the difficulty in determining the loss in weight with sufficient accuracy. A diminution with the pressure certainly is to be expected. The total loss in weight of the globe filled with helium is 1.73 mg., or one per cent. of the total weight of helium contained in the globe (0.168 g.). That is, apparently 10.7 ml. of helium leaked through the glass in the course of one year. Since the globe weighs 151 g. and has an interior surface of 500 cm^2., this is at the rate of 0.059 mm^3. per day per cm^2. of Pyrex glass of average thickness 1.34 mm. This corroborates the result of the experiments described first.

One possible source of error in the experiment lies in the well-known difficulty of making perfect seals with Pyrex glass. Naturally this point received especial attention. Since the pressure in the globe was sometimes greater, but usually less, than that of the atmosphere, and since the loss of helium was so slow and so regular, mechanical leakage seems unlikely. Furthermore the globe held a high vacuum for a long period before it was filled with helium.

These observations raise the question as to the effect of leakage upon the recent determinations of the density of helium by Baxter and Starkweather,[2] which were carried out in Pyrex globes. The globes used in the earlier density determinations were practically identical with the one used in the foregoing leakage experiment, and may be assumed to have behaved in the same way. Those used in the later density determinations had capacities of a trifle over two liters, and an average thickness of 1.11 mm. Since the surfaces of these globes were 1.6 times as large and the thickness 0.8 that of the globe used in the leakage experiment, the leakage may reasonably be estimated to be twice as great, *i.e.*, 0.01 mg. helium per day. Because the weight of helium in each density experiment was in every case the average of several weights obtained ordinarily during the 24 to 48 hours following the filling, the error from this source can hardly exceed 0.005 mg. in the weight of one liter and 0.01 mg. in the weight of 2 liters of helium. This quantity lies outside the accuracy of the density determinations.

The leakage experiment is being continued.

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DIFFERENCES OBSERVED IN THE CONDITION OF THE SEA WATER AT THE MARGINS OF TWO OPPOSING TIDAL CURRENTS

In bays and estuaries where the range of the tides is considerable, it is a familiar sight to observe the meeting of flood and ebb currents along a sharply defined line, rendered visible either by the agitation of the water, or by a narrow zone of flotsam, or by differences in the color of the water, as when one current is turbid and the other clear. When the currents thus meeting are of considerable velocity (in Puget Sound they may attain a velocity at times of five or six miles an hour), the water is agitated and thrown into eddies, producing a dull roar. A "tide-rip" of this description may be seen and heard for a distance of several miles.

On July 23, 1927, the authors, in conjunction with Messrs. George H. Hitchings and Seldon P. Todd,

[2] Baxter and Starkweather, *Proc. Nat. Acad.*, 11: 231 (1925); 12: 20 (1926).

were collecting samples of sea water in the channel north of San Juan Island, when the characteristic roar of a tide-rip was heard. As it approached the boat, a marked difference in the color of the waters on each side of the rip was observed, the water of one current being a decided blue, while that of the other was a distinct green. The line of demarcation was very sharp. The boat drifted so that it was directly on this line, with the blue water on one side, the green water on the other. With the utmost haste, samples were taken simultaneously from both sides of the boat, approximately twenty feet apart. On analysis, these samples gave the following results:

	Green water	Blue water
Temperature, °C.	16.4	14.0
pH (corrected for salt error after Ramage and Miller[1])	8.16	7.94
Mobile CO_2, mg. per liter	0.84	1.83
Combined CO_2, mg. per liter	63.64	78.79
Total CO_2, mg. per liter	64.48	80.62
Chlorinity, gms. per kilo	11.94	14.74
Specific gravity (δt, after Knudsen[2])	15.40	19.77
Osmotic pressure (calculated from equations of Stenius[3])	14.79	18.91

The green water was without doubt sea water coming in from the Gulf of Georgia, which had been diluted by the inflow of the Fraser River. This would account for its higher temperature, lower chlorine content and specific gravity, and probably for the color, which may be attributed at least in part to suspended matter. The clearer blue water was that flowing in from the Strait of Juan de Fuca, thus representing less diluted sea water.

In explanation of the higher pH value and the lower content of carbon dioxide, both mobile and bound,[4] we may assume a more rapid rate of photosynthesis in the diluted water from the Gulf of Georgia, because of its higher temperature or for other reasons.

It is a matter of considerable interest, and of no little biological importance, that such marked differences in the condition of the water should occur but a few feet apart, in opposing tidal currents. A sudden change of 2.4° C. in temperature, 0.22 pH unit in hydrogen-ion concentration and 2.8 parts per thousand of chlorine, with corresponding changes in associated conditions, would be presumed to exert a decided effect on marine organisms.

The differences recorded occurred, of course, at the surface of the water. It is doubtful that bottom living forms would be exposed to so wide a range of conditions (the depth at this locality was 175 meters). Plankton organisms would be carried with their respective currents, and hence would be exposed to these differences only at the very margins of the tide rip. But fish and other nekton forms must be assumed either to make extensive and frequent migrations with the tides or to be able to accommodate themselves to differences in the condition of the water more sudden and marked than some authors have considered to be the case.

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[1] Ramage, W. D., and Miller, R. C., *Jour. Amer. Chem. Soc.*, 47, 1230, 1925.

[2] Knudsen, M., Hydrographische Tabellen, Copenhagen, 1901.

[3] Stenius, S., öfversigt af finska vetenskaps-societetens förhandlingar, 46, No. 6, Helsingfors, 1904.

[4] Carbon dioxide was determined by aspiration into a standardized solution of barium hydroxide.

THE INFLUENCE OF CO_2 TENSION ON THE OXYGEN DISSOCIATION CURVE

THE influence of acids or CO_2 tension in lowering the oxygen dissociation curve is a well-known phenomenon.[1, 2] This has been interpreted as an evidence that CO_2 in the capillary bed increases the dissociation of oxygen from its combination with hemoglobin.

Whereas we have an adequate account of the mechanism involved in the displacement of CO_2 by O_2 in the pulmonary capillaries, no adequate account has been offered for the reverse mechanism occurring in the tissues whereby, as mentioned above, CO_2 tends to displace oxygen and thus lower the oxygen dissociation curve.

It occurred to us that perhaps the process can be simply explained if we assume a double dissociation process of oxyhemoglobin ($HHbO_2$) as follows:

$$(1)\quad HHbO_2 \rightleftarrows HHb + O_2\uparrow$$

$$(2)\quad HHbO_2 \rightleftarrows H^+ + HbO_2^-$$

Equation (1) presumably takes place since O_2 is absorbed by the tissues and reduced hemoglobin is obtained. Equation (2) is evidently present if we accept the well-known fact that oxyhemoglobin acts as an acid and consequently would dissociate accordingly. It would therefore behave as a weak electrolyte as follows:

$$K = \frac{[H^+]\quad[HbO_2^-]}{HHbO_2}$$

Now, with the formation of carbonic acid in the tissues the concentration of hydrogen ions $[H^+]$ is

[1] Bohr, Hasselbalch and Krogh, *Skand. Arch. f. Physiol.*, 16, p. 602, 1904.

[2] Barcroft, "The Respiratory Function of the Blood," 1914.

increased and hence in equation (2) the reaction would be driven back and thus tend to increase the concentration of the undissociated $HHbO_2$. Or, simply stated, in terms of the law of mass action, the ionization of $HHbO_2$ would be repressed.

An increase in concentration of $HHbO_2$ would necessarily involve a shift in the equilibrium of equation (1) to the right. The consequence would be an increase in the production of O_2.

It is thus suggested that by presenting this idea of a double dissociation of $HHbO_2$, a chemical mechanism has been offered to account for the lowering of the oxygen dissociation curve by an increase in the CO_2 tension.

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THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

THE REGULAR FALL MEETING OF THE EXECUTIVE COMMITTEE OF THE COUNCIL

The regular fall meeting of the executive committee of the association council was held on October 21 at the Cosmos Club, in Washington, with the following members present: Cattell (chairman), Curtiss, Humphreys, Johnston, Kellogg, Livingston, Moulton, Ward. Those absent were: Osborn, Pupin and Wilson. Three sessions were held, forenoon, afternoon and evening. Most of the members lunched together, with Dr. Dayton C. Miller and Mr. G. L. Bowe, who were present by invitation to discuss the proposal that the annual meeting of December, 1930, be held in Cleveland, Ohio. The committee dined together as usual. The following is a summary of the business transacted.

(1) The permanent secretary reported that the minutes of the last meeting had been approved by mail.

(2) The treasurer's annual report was accepted and referred to the council. The endowment fund is now $143,976.66 and the treasury reserve is $6,119.00, the latter having been increased by $1,754.92 in 1927-28. There is available for appropriation in 1929, $4,904.48.

(3) The permanent secretary's financial report for 1927-28 was presented, accepted and referred to the council.

(4) The permanent secretary's budget for 1928-29 was approved.

(5) The permanent secretary's report on membership was accepted. In the year just closed the membership has increased from 13,930 to 15,437, a net gain of 1,507. The total enrolment shows a corresponding gain of 1,466; therefore the membership has increased considerably more than the total enrolment. The membership now represents 94.54 per cent. of the total enrolment, the latter including names still carried on the roll although one or two years in arrears on September 30, 1928.

(6) The permanent secretary reported on invitations received from institutions in Cleveland, Ohio, asking the association to hold its meeting of December, 1930, in that city. The following institutions have sent very cordial invitations: The City of Cleveland, the Convention Board of the Cleveland Chamber of Commerce, the Cleveland Board of Education, the Cleveland School of Art, the Cleveland Museum of Natural History, the Cleveland Museum of Art, Western Reserve University, Case School of Applied Science, John Carroll University, Huntington Polytechnic Institute.

(7) It was voted that the executive committee favors holding the meeting of December, 1930, at Cleveland, Ohio, if satisfactory arrangements can be completed.

(8) It was voted that the executive committee would regard as a satisfactory financial arrangement the underwriting of a local fund of $7,500 for the proposed Cleveland meeting.

(9) The permanent secretary reported on the nominations (received from the fellows) for section officers, which are still to be reviewed and balloted on by the section committees. It was voted that the candidates for these offices receiving the largest number of votes from the section committee in each case are to be asked if they would accept the election. In the case of nominations for the section chairmanships and secretaryships, if they intimate their willingness their names are to be presented to the council for election. If any find it impossible to accept, another candidate is to be selected by the section committee, etc. The result should be that the names presented to the council (as nominations for section chairmanships and section secretaryships and as elections for section committee memberships) will be those of the most suitable and available persons, in the judgments of the respective section committees. The permanent secretary was instructed to carry out the nomination ballots for the section officers in accordance with these ideas.

(10) The permanent secretary reported progress in the securing of presidential nominations from the members. Thus far, 1,638 votes have been received.

(11) A report was presented and accepted from the Committee on Linguistic Science in the association (Dr. E. S. Sapir, chairman). This report is summarized as follows: The proposal that a special section be organized for linguistic science would be allowed to lapse for the present in view of the present proposal to reorganize the association into about three

sections, with subsections. In case that reorganization is accomplished, it is recommended that the linguistic sciences be named in a section on social sciences. A program for linguistic research is in preparation for the approaching New York meeting, to be arranged under the auspices of Section L (Historical and Philological Sciences) and presented in connection with the programs of the Linguistic Society of America, which is affiliated with the American Association.

(12) The Committee on Linguistics in the association reported the appointment of Dr. G. M. Bolling, Ohio State University, Columbus, Ohio, to be chairman of Section L for 1928, and the appointment of Doctor L. Bloomfield, also of Ohio State University, to be secretary for 1928. This report was approved.

(13) On recommendation of the Committee on the Place of Science in Education (Dr. Otis W. Caldwell, chairman), an executive committee of that special committee was named and empowered to add to its own membership as may be desirable. The membership of this executive committee is as follows: Otis W. Caldwell (chairman), J. McK. Cattell, E. R. Downing, I. Howerth, B. E. Livingston.

(14) A report was presented from the Committee of One Hundred on Scientific Research (Dr. Rodney H. True, chairman), and the executive committee expressed its hearty thanks to Doctor True for his work on behalf of the Committee of One Hundred. A program of several invited papers on the economic status of science workers is being arranged for the approaching New York meeting.

(15) It was reported that the Southwestern Division of the association adopted a resolution at its recent meeting, approving of the work of the Committee of One Hundred and requesting the association to support the further progress of that work as much as possible. The Southwestern Division appropriated the sum of $100 for use by the Committee of One Hundred.

(16) A report was accepted from the association's special Committee on Source-Books in the History of Science (Dr. Gregory D. Walcott, chairman). Arrangement has been made by which this series of books is to be published by the McGraw-Hill Book Company. The Carnegie Corporation has made a grant to aid in the preparation of the manuscripts under the general editorship of Dr. Gregory D. Walcott, of Long Island University, Brooklyn, New York. The project is in a very satisfactory state of progress and the first volume, by Dr. Harlow Shapley, "A Source Book on Astronomy," is now in press.

(17) The executive committee considered the proposal that the association be reorganized with respect to sections, but no action was taken. It was noted that this topic is to be discussed at the New York session of the Secretaries' Conference.

(18) The permanent secretary reported the receipt of an anonymous gift of $500 from a member for current use by the association in carrying on its work and the executive committee expressed its hearty thanks to the donor.

(19) The special committee on the Relations of the Social and Economic Sciences to the association (Dr. Edwin B. Wilson, chairman) reported the appointment of Dr. C. F. Roos, 209 College Avenue, Ithaca, New York, to be secretary of Section K (Social and Economic Sciences) for 1928. This report was approved.

(20) Eighty fellows were elected, distributed among the sections as follows:

Section B, 2	Section F, 3	Section N, 2
Section C, 3	Section H, 1	Section O, 35
Section E, 1	Section K, 1	Section Q, 2
	Section M, 30	

(21) The Western Society of Naturalists was elected to affiliation with the association. This society has a membership of 161, 121 of this number being members of the American Association, while 112 of these are fellows.

(22) A proposal that the association might undertake to arrange in some way for archives for the preservation of scientific data that are not published was discussed and the committee voted that it is at present impracticable for the association to attempt to arrange for such archives.

(23) The executive committee recommended to the council that it consider the establishment of a special class of members of the association, to include members who have paid annual dues for fifty years, such members to be relieved of payment of further dues.

(24) The sum of $100 was appropriated from the treasurer's available funds to aid the National Finance Committee on Botanical Nomenclature (Dr. A. S. Hitchcock, chairman).

(25) The permanent secretary was authorized to complete the committee on the New York award of the association prize of one thousand dollars, the personnel of this committee to be selected from the vice-presidents and retiring vice-presidents of the association.

(26) It was voted that the election of officers be made a special order of business for the council session to be held Saturday morning, December 30.

(27) The executive committee adjourned to meet at the Lincoln Hotel, New York City, on the forenoon of Thursday, December 27.

Burton E. Livingston,
Permanent Secretary